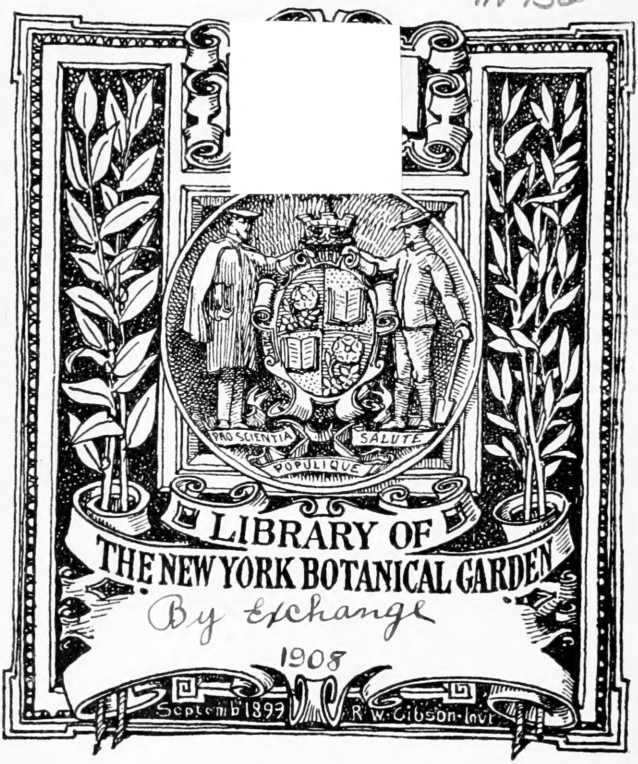
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EIGHTEENTH ANNUAL REPORT

OF THE

CORNELL UNIVERSITY

AGRICULTURAL EXPERIMENT STATION

Ithaca, N. Y.

1905.

TRANSMITTED TO THE LEGISLATURE JANUARY 17, 1906.

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IN ASSEMBLY,

JANUARY 17, 1906.

EIGHTEENTH ANNUAL REPORT

OF THE

Agricultural Experiment Station of Cornell University.

STATE OF NEW YORK:

DEPARTMENT OF AGRICULTURE,

ALBANY, *January* 17, 1906.

To the Honorable the Legislature of the State of New York:

In accordance with the provisions of the statutes relating thereto, I have the honor to herewith transmit the Seventeenth Annual Report of the Agricultural Experiment Station at Cornell University.

CHARLES E. WIETING,

Commissioner of Agriculture.

ORGANIZATION

Of the Cornell University Agricultural Experiment Station.
(1904–5.)

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Office of the Director, 17 Morrill Hall.

The regular bulletins of the Station are sent free to persons residing in New York State who request them.

REPORT.

Office of the President, Cornell University,

Ithaca, N. Y., *December* 1, 1905.

The Governor of the State of New York, Albany, N. Y.
The Secretary of the Treasury, Washington, D. C.
The Secretary of Agriculture, Washington, D. C.
The Commissioner of Agriculture, Albany, N. Y.

Sir.—I have the honor to transmit herewith the eighteenth annual report of the Agricultural Experiment Station of Cornell University, in accordance with the Act of Congress of March 2, 1887, establishing the Station, and also the report for the year ending September 30, 1905, of the work conducted under the Bureau of Extension Teaching in Agriculture maintained by the State of New York.

This document contains the report of the Director and the special reports of his several scientific coadjutors, as well as copies of the bulletins, Nos. 222 to 232 inclusive, the *Junior Naturalist Monthly*, new series, Vol. I, Nos. 1 to 8 inclusive, and the Home Nature-Study Course leaflets, new series, Vol. I, Nos. 1 to 4 inclusive, together with an itemized statement of receipts and expenditures of the Federal Experiment Station, and a statement of the scheme of expenditures under the State appropriation for the extension of agricultural knowledge.

The report of the Director is devoted entirely to an exhaustive survey of the winter-courses in agriculture (State extension work), including a history of these courses in other institutions and a detailed statement of the aims, methods employed, and results accomplished in this work at Cornell University. The total enrollment in these courses last winter was 201, as compared with 136 the year preceding.

The remainder of the report is arranged under 11 separate headings representing the various departments under which the work of the Station is carried on, and wherever necessary each department is further subdivided to show precisely the work which is being done under the Federal fund for experiment and research and the State fund for extension teaching in agriculture, respectively.

I. The department of agronomy, in its investigations under the Federal appropriation, has confined its energies almost entirely to the solution of problems connected with the live stock interests of the State, a total of 1,385 plats out of more than 1,500 under experiment having been devoted to forage crops. The cooperative experiments in agronomy (State extension work) have as their objects (1) to gain information in regard to the soil and crops under experiment, (2) to extend the educational influence of experiments to the farmers who are doing the work and to their neighbors who observe them, and (3) to promote a closer relationship and better understanding between the farmers of the State and the College of Agriculture. These experiments are carried on very largely by the farmers themselves on their own farms, but under the supervision and direction of the College of Agriculture, and there are now in progress under this head 498 experiments, distributed through 44 counties of the State and requiring the use of about 1,000 separate plats. The subjects under investigation include alfalfa, oats, fertilizers, potatoes, soy beans, field beans, buckwheat, vetch, etc.

II. The Federal Experiment Station work in animal husbandry has been continued along the same lines as formerly, namely, experiments in meat production with cattle, sheep, and swine. The work in the breeding and development of dairy cattle has also progressed satisfactorily. The State extension work in this department has been almost wholly devoted to the supervision of records of thoroughbred cattle, including 700 Holstein cows belonging to 85 different owners throughout the State, and about 10 different herds of Guernsey breeders.

In the sub-department of poultry husbandry (maintained by special State appropriations) the work has consisted of instruction in the winter poultry-course, which, though offered for the first time this year, enrolled 17 students; the preparation of lessons for the Farmers' Reading-Courses, and of articles for the *Junior Naturalist Mon hly;* and, finally, the investigation of a number of the more important problems of interest to poultrymen, including a study of the comparative advantages for egg production and health of fowls, of different styles of pens and different kinds of food, and the best methods of destroying certain external poultry parasites. Of the students pursuing the winter-course in poultry, all who desired positions have secured them at an, advanced salary and the professor in charge reports that the demand for skilled poultrymen of this sort is greater than the College can supply.

III. In Horticulture the Federal Experiment Station work has comprised investigations into (a) the propagation of the sour cherry, (b) the influence of shade on plants (continued from last year), (c) whether acetylene light is to be a factor in the forcing of plants, (d) the oriental pears and their hybrids in relation to adaptation and commercial value, and (e) among minor investigations, tests of the newer vegetables, the forcing of strawberries, and greenhouse crops. Under the head of extension work in horticulture there are for report (a) the orchard survey, which was continued in Niagara county during the summer of 1905, (b) the investigation of horticultural industries, particularly the grape industry which has suffered in recent years from root-killing and epidemics of fungous diseases. The department has collected some valuable information on these subjects, which will soon be presented in bulletin form. (c) Extension teaching throughout the State and at the University, including addresses before granges, farmers' clubs, and institutes by special request of these organizations and lectures to the winter-course students in agriculture. To meet an increasing demand for special winter-course instruction in horticulture, courses in fruit growing, vegetable gardening, and floriculture have been arranged for the winter of 1906.

IV. The most important features of the Experiment Station work in entomology were the completion of the study of the grape-berry moth and the investigation of two comparatively new shade-tree pests and of the bronze birch borer, insects which have wrought great destruction in parks and on private grounds throughout the State. Their life histories have been studied and practical methods of combating the pests have been found and tested. Co-operative experiments (State extension work) have also been conducted at different points throughout the State looking to the control of insect pests, such as the grape root-worm, the plum and quince curculios, and the rose-chafer, and some valuable results have been attained. The entomologist further reports the appearance in many sections of the State of the dreaded San José scale and with a view to aiding the fruit growers of the State in combating this evil, he has recently started a series of experiments with the new soluble petroleums against this scale insect.

V. In the department of agricultural chemistry work under the Federal fund has been devoted to the examination of samples of sweet corn for sugar content, with the resulting discovery that sugar content may be increased by proper selection of seed, and to analyses of samples of cabbage and root crops in cooperation with the department of agronomy, which is endeavoring to grow some easily digested food of proper composition to take the place of western grains and by-products. Likewise the extension work has comprised the analyses of samples of lime, fertilizers, feeds, soil, weed destroyer, apples, etc., all in response to requests from various parts of the State. During the coming year this department will make a study of the conditions under which the oat crop has failed in different sections of the State.

VI. The botanical division of the Federal Experiment Station has continued its investigations into the culture of mushrooms and its studies of the higher fungi, and a large correspondence has been carried on with persons about the State seeking aid in the determination of species. Special research work has included a study of the embryology and development of the common mushroom, investigations as to whether the substance of the fleshy fungi possesses any food value for the higher plants after decay, and the determination of the life histories of several parasitic fungi affecting fruits and vegetables. The chief lines of investigation in the State extension division of this department have concerned the nature and cause of blight canker of apple trees and methods of destroying it, the diseases of ginseng, the alfalfa leaf spot, and bean diseases, and many valuable results have been secured.

There remain for report certain lines of activity which are maintained exclusively by the State appropriation for the promotion of agricultural knowledge, namely, the extension courses in dairying, nature study, and general agriculture for farmers, farmers' wives, school children, and school teachers throughout the State.

VII. The short winter-course in dairying (State extension work) was attended last winter by ninety-one regular students coming from thirty different counties of this State, and from two neighboring States (students from other States pay tuition), and by thirty-one students from the short general agricultural course. The practical value of these short courses is very strongly illustrated by the reports of students who attended the dairy course a year ago, practically every one of these students stating that upon the completion of the course they obtained positions of greater responsibility and larger salary than those they had held before entering the course. During the season, 108 visits were made to factories of former dairy-course students throughout the State and their work criticized, such inspections being considered a very valuable supplement to the dairy-course itself. On the experimental side, the sources of milk contamination have been studied and some valuable results have been obtained.

VIII. The Bureau of Nature-Study, conducted as a part of the State extension teaching in agriculture, has organized and conducted 486 Junior Naturalist Clubs with a total enrollment of 14,318, distributed among all the counties of the State except four. Fifty topics have been treated and the supervisor has, as usual, carried on a voluminous correspondence relating thereto.

IX. In the Home Nature-Study Course (State extension work), four lesson leaflets have been published and circulated among the school teachers of the State, the issues averaging nearly 2,000 copies each. Each of these leaflets covered several distinct subjects so that this work aggregated the placing of 23,000 practical, simplified lessons in nature study into the hands of the teachers of New York State. The topics covered were birds, trees, plants, insects, and fish. This work, which has heretofore been largely confined to the town and city schools, is now being carried to the rural schools with much success, and the demand for leaflets this year was greater than ever before.

X. The third year of the Farmers' Wives' Reading Course (State extension work) shows a live membership of 17,800 women in the State. The course now covers three series of five bulletins each, dealing with The Farm House and Garden, The Farm Family, and Food and Sanitation.

XI. The Farmers' Reading Course is really a precursor of the short winter-course in agriculture described in the report of the Director. The registration this year in these courses aggregated 9,554 new readers.

In all the above extension courses discussion papers are sent out regularly and returned by the readers, and whenever questions arise on which more specific information is desired a personal letter in every case is sent in reply.

Such, in brief, is the nature of the work that has been carried on by the Cornell University College of Agriculture under the appropriations for the Federal Experiment Station and the State Bureau for Extension Teaching in Agriculture. That the work is meeting a real need of the agricultural population of the State is evidenced by the growing enthusiasm and hearty support which the College is receiving not only from individual farmers but also from all the agricultural societies of the State, by whose representatives the College and Station are inspected annually on the invitation of the Board of Trustees of the University.

Respectfully submitted,

J. G. SCHURMAN,

President of Cornell University.

REPORT OF THE DIRECTOR.

To the President of Cornell University:

SIR.—I herewith submit a report of two general lines of work conducted by the College of Agriculture of Cornell University: (1) of the Federal Experiment Station for the year ending June 30, 1905; (2) of the Extension Work maintained by the State of New York for the year ending September 30, 1905.

This report consists of the reports of the heads of the various departments concerned, together with bulletins and nature-study publications that have been published in the year between July 1, 1904, and September 30, 1905, except Bulletins 221, 226 and 229, which have been already issued by the State. These various reports explain succinctly the main lines of effort in the research work and extension work of the College of Agriculture. It may be well for me, however, to expand these reports by a more extended account of the winter-courses in agriculture conducted at the college, since these are now coming to have great importance to the agricultural interests of the state. The extension work maintained by the State of New York is conducted along three general lines: (1) direct teaching at the university (the winter-courses); (2) correspondence teaching work (reading-courses and nature-study work); (3) demonstrational experiment work on farms in various parts of the state.

The winter-course work which I now desire to describe falls into three main divisions: (1) the General Agricultural Winter-Course designed for farm youth who do not desire to specialize; (2) the Dairy-Course for those who are to make a specialty of dairy farming, or who desire to conduct creameries or similar institutions; (3) the Poultry-Course for those who desire to specialize in poultry husbandry. It has now been determined to add two winter-courses to this list for the coming winter, one on Horticulture, and one on Home Economics.

I shall now make a general discussion of winter-course work and append thereto the courses of study as given in the three winter-courses for 1905, and also a list of the students who were engaged in those courses.

The winter-course work is really unacademic work in the sense that it does not require academic standards for admission, is not long continued and does not lead to degrees. However, the work is of the greatest possible value to the welfare of the state. If a few hundred energized young men can be sent into the agricultural districts each year the results within a generation will be beyond all calculation. Since there are no secondary schools that are prepared to give the kind of instruction that is demanded by the agricultural people, it has devolved upon the agricultural colleges to take up these questions, with the result that winter-courses have been organized in very many institutions of the country. These winter-courses constitute a stage or epoch in the revolution of industrial education. It is possible that the future will see them segregated into institutions by themselves, although it is highly probable that these institutions will in larger part be directly connected with the regular agricultural colleges. In order that the whole subject of winter-course instruction may be presented in brief space I will make a somewhat full discussion of it. This I consider to be important at this time in order to place the whole subject in its proper relations and because also we seem now to have come to a point where a rather thorough reorganization of the work should be made. I, therefore, record the data of our winter-course instruction.

The desire to get nearer to the people has led to the establishment of short and winter courses in many of the agricultural colleges. In these it is the purpose to give the pupil knowledge of some of the fundamental principles of science as applied to agriculture and to offer him some training in a few of the more careful handicrafts of the farm. Winter-course instruction, as now understood, appears to have originated with the University of Wisconsin. However, many efforts were made in earlier times in the direction of popular and abbreviated courses. This effort found expression in the Ohio Agricultural College, established at Oberlin in 1854. In 1866, Yale offered a "shorter course in agriculture," with the following announcement:

"For this course the instruction is so arranged that the more important topics, viz.: Practical Agriculture, Agricultural Chemistry and Physiology, Agricultural Zoology, Physical Geography, Forestry, etc., are discussed during the fall and winter terms of each year (September to April, with vacation of two weeks at the holidays). Those who desire can thus attend, during seven months of the year, such a selection of the most useful exercises from the studies of the full course as will occupy their time profitably."

Ohio State University at Columbus, the outgrowth of the earlier institution at Oberlin, made an effort in the winter of 1877–8 to interest farmers in a course of lectures. President Orton made the following reference to the subject in his annual report dated November 6, 1878:

"An effort was made last winter to establish in the College a course of lectures on the sciences relating to agriculture for the benefit of the young farmers of the state who are unable to pursue an extended and regular course of study. The scheme proposed four lectures a day for ten weeks. It was to be illustrated and made as serviceable as possible by the use of the excellent facilities of the institution. No entrance examinations were required. The scheme was widely advertised, but there was no adequate response. Seven applicants appeared, but it was not deemed right to devote the necessary time and effort required for the lectures to so small a number."

The following winter a more ambitious effort was made of four weeks duration, and it met with success. This enterprise, however, was not so much a short course for students as a lecture course for farmers.

In the annual reports of the following November (1879) Professor N. S. Townshend writes as follows:

"The short course to farmers given at the University during January, 1897, may properly be noticed here.

"To make the State University more immediately serviceable to the agricultural interests of the state, the Board of Trustees determined to provide a course of free lectures on topics of practical interest to farmers. These lectures were given by the professors of the University beginning January 9 and continued four weeks, four or more lectures each day. The experiment was a decided success; the total number of farmers in attendance exceeded 100, and the regular daily attendance was upwards of 50.

"At the close of this course of lectures those who had attended, formally and unanimously expressed their satisfaction with the course of instruction, and united in a request that a similar course should be given at the University in January, 1880."

This course was not continued long.

The short course in agriculture at the University of Wisconsin opened the first of January, 1886, and continued 12 weeks with an attendance of 19 pupils. This is without doubt the oldest short course which has continued growing in attendance. In 1890 there was added a course in dairying, which was practically a short course in that line and a branch of the regular short course. Two students registered that year and 70 the next.

Following these early experiments winter-course instruction in agriculture has now been established in the following institutions:

South Dakota Agricultural College..............	Brookings, S. D.
Purdue University........................	Lafayette, Ind.
Colorado State Agricultural College..............	Fort Collins, Colo.
Michigan State Agricultural College..............	Agricultural College, Michigan.
University of California........................	Berkeley, Cal. (in 1903 had 29 students in dairying).
University of Minnesota........................	St. Anthony Park, Minn.
Massachusetts State College of Agriculture.......	Amherst, Mass.

New Mexico College of Agriculture and Mechanic Arts	Agricultural College, N. M.
University of Wisconsin	Madison, Wis.
Delaware College	Newark, Del.
University of Missouri	Columbia, Mo.
Oklahoma Agricultural and Mechanical College	Stillwater, Okla.
University of Nebraska	Lincoln, Neb.
Montana State College of Agriculture and Mechanic Arts	Bozeman, Mon.
Tuskegee Normal and Industrial School	Tuskegee, Ala.
North Dakota Aricultural College	Agricultural College, North Dakota.
Pennsylvania State College of Agriculture	State College, Pennsylvania.
Texas Agricultural and Mechanical College	College Station, Texas.
University of Tennessee	Knoxville, Tenn.
Oregon Agricultural College	Corvallis, Ore.
Louisiana State University	Baton Rouge, La.
University of Maine	Orono, Me.
Rhode Island College of Agriculture and Mechanic Arts	Kingston, R. I.
Maryland Agricultural College	College Park, Md.
University of Idaho	Moscow, Idaho.
Iowa State College	Ames, Iowa.
Kansas State Agricultural College	Manhattan, Kan.
Mississippi Agricultural and Mechanical College	Agricultural College, Mississippi.
New Hampshire College of Agriculture and Mechanic Arts	Durham, N. H.
University of Georgia	Athens, Ga.
Ohio State University and Dairy School	Columbus, O.
Agricultural College of the University of Wyoming	Laramie, Wyo.
Agricultural College	Logan, Utah.
Washington State Agricultural College	Pullman, Wash.

Our own winter-course was opened in 1894. It was first a general course in agriculture extending 11 weeks from the first week in January, as it does at the present time. In 1894, however, a dairy-course was established; and in the present year a poultry-course was established. The faculty of the College of Agriculture has now voted to organize a horticultural-course for the coming winter, which will make four departments or branches in the winter-course work. The total registration in the winter-course at Cornell University from the organization of the enterprise is as follows:

1894	61
1895	77
1896	83
1897	60
1898	93
1899	89
1900	83
1901	94
1902	96
1903	121
1904	136

The past winter's work is typical of the methods and purposes of this kind of educational enterprise. It is remarkable how much actual information the students receive in the 11 weeks and to what a pitch of enthusiasm their work carries them. Into those three months of work there is condensed a very wide range of most direct and purposeful instruction. I now submit a somewhat detailed report of the winter-course work for the present university year.

GENERAL REPORT OF THE WINTER-COURSE.

The whole number of winter-course students enrolled in 1905 was 201. Of these 91 were enrolled in the Dairy-Course, 93 in the General Agriculture-Course, and 17 in the Poultry-Course. Ten were women. One of the women was enrolled in the Dairy-Course, six in the General Agriculture-Course and three in the Poultry-Course.

The average age of the students in all the winter-courses in 1905 was 25 years. The average age of the students in the Dairy-Course was 27 years, in the General Agriculture-Course 23 years, and in the Poultry-Course, nearly 29.

Two of the students fell out very early in the session. Of the 199 students remaining, 173 came from the country and 26 from cities of over 10,000; 189 were residents of New York; one came from Pennsylvania, one from Connecticut, one from Virginia, two from Minnesota, two from Maine, one from Illinois, one from Wisconsin, and one from Iowa. The inerease in the number of students coming from towns and cities is marked.

Of the 91 students in the General Agriculture-Course 72 had high school or academy training previous to their enrollment in the winter-course; eight were college graduates; 11 had a common school education. In the Dairy-Course, 47 of the 91 students had high school or academy training previous to their enrollment in the winter-course, six had college education, and 38 had common school education. In the Poultry-Course, 11 of the 17 had high school or academy training, three had college education, and three had common school education. In all three courses, therefore, there were 130 students who had had high school training, 17 who were college graduates, and 52 who had had a common school education.

Of the 91 students in the General Agriculture-Course, 14 desired to secure positions on the completion of their course. Positions have been secured for most of these men at salaries ranging from $25 a month with board and lodging, to $50 a month with board and lodging. The remaining 81 students in the General Agriculture-

Course returned to their farms. Of this number 10 have farms of their own; the remainder are with their fathers, or otherwise situated.

Of the 91 students in the Dairy-Course, 53 desired to secure positions on the completion of their course. Positions have been secured for 35 of these men, at salaries ranging from $24 a month with board, to $75 a month. All others who are fitted for responsible positions in dairy work have been recommended to places and it is expected that they will soon be located for the season.

Of the 17 students in the Poultry-Course, eight have secured positions as poultrymen, five have returned to their homes for poultry keeping, and four are continuing their studies in special work at Cornell.

Of the 91 students in the General Agriculture-Course, 25 have expressed a desire to return for further work, either in the special winter-course that it is hoped may be offered, or as special students. These have been admitted to special work whenever they find it convenient to return. In the Dairy-Course five of the students have expressed a desire to return for a two or four year course, and a larger number have expressed their intentions of returning for another winter-course period. In the Poultry-Course six of the students have expressed their intentions of returning to Cornell for special work next year.

In the General Agriculture-Course 30 of the 91 students were members of The Grange.

The Dairy-Course.

Students taking this course may be divided into two groups,—those who have had one or more seasons of practical work before coming to Cornell and those who have had little or no experience of this kind. We do not require previous experience in a commercial plant, but always advise it; and those who thoroughly understand the routine of creamery, cheese factory, and other dairy work are usually best fitted for responsible positions after completing the Dairy-Course. There are some notable exceptions to this rule, however, for not infrequently men who knew nothing whatever of practical dairy work before coming to the dairy school, have secured responsible creamery or cheese factory positions and filled them with credit alike to themselves and the school. For this reason, it has seemed unwise and unfair rigidly to enforce a rule that every person entering the course must have had a certain amount of actual experience in dairy work.

In the first and larger part of the winter-course term, all students receive instruction in all branches offered. This is to give them a broad foundation upon which they can specialize. For example, the prospective cheese maker is expected to take butter making, for he will learn many things important for him to know easier in the butter factory than in the cheese factory. Likewise, it is well for the butter maker to understand the main principles of cheese making. Furthermore, it often happens that a man in a factory must change from manufacturing one product to the other, either temporarily or permanently, and he might lose his position if he did not understand the first principles of handling milk in more than one way. Thus far, the practical work has been limited to butter making, cheese making, milk testing, dairy mechanics and market milk. It is desired to give instruction also in other branches of dairy work, and this will be undertaken as soon as the larger facilities in our new building are available.

Great emphasis is given to the practical work as compared with that in the class and lecture rooms. This year we used about 6,000 pounds of milk per day. It comes to us in small quantities from nearby dairy farms, and in larger quantities by teams and rail from dairies six to 25 miles distant. The milk is issued in lots of 300 to 500 pounds to groups of two, three or four students and they carry it through the entire process of manufacture, as would be done in a factory where one man handles 3,000 to 5,000 pounds of milk. Report blanks are used upon which every step of the work is recorded, and care is taken to note the losses, over-runs, and flavors and to study their causes.

The detailed instruction is practically as follows: The principles of different kinds of dairy work and subjects closely allied to dairying are explained in lectures and recitations. Thorough drill in keeping accounts and in all kinds of dairy mathematical problems is given in the class-room. In cheese making care is taken first of all to teach correct principles, and these bring in some practices which unfortunately are not followed in a large number of factories throughout the State. The reason for the backward condition of many cheese factories is that methods of cheese making are changing and there are always a large number of makers who are following old, out-of-date rules and customs. Instruction includes the use of starters and the treatment of difficulties commonly encountered in factories. Special attention is given to the improved fermentation test and experiments are conducted to show the effect of a larger or smaller percentage of fat in milk upon the quantity and quality of cheese.

In butter making, the instruction is similar to that in the cheese room. The latest and most improved methods are taught; and many of these methods are sadly needed in a large number of factories throughout the State. In this department, special attention is given to the saving of wastes incident to dairy manufacture. Butter making machinery has been so far perfected that the former enormous waste of fat can now be almost entirely avoided. Every step of the work is watched with the aid of the fat tester, and if there is an unusual loss at any point the cause is looked for and removed as promptly as possible. Unquestionably tens of thousands of dollars are lost annually because of carelessness in respect to unnecessary waste of butter-fat.

In milk testing, the usual methods are taught and the students are shown how to detect common adulterations and the presence of certain preservatives.

In dairy mechanics, attention is given to the management of the boiler and engine and the installation and care of shafts, pulleys, belts, etc. It would be difficult to overstate the importance of this branch of the work. Every year many otherwise competent men lose their positions or fail to give satisfaction because they do not understand anything about dairy mechanics. Our students give two or three half days each week to this work; and in addition, they study the construction of separators and other dairy machines which have now become more or less complicated.

In market milk, the methods of handling milk for the market are taught. These include standardizing, bottling, cooling, etc., and special emphasis is given to sanitary principles.

It is believed that in the near future we should offer another short dairy-course each year for those butter makers and cheese makers who have had long experience and can leave their work only three or four weeks. Offering such a course would necessitate some changes in the longer short-course which we have been giving each winter.

Poultry-Course.

There were 17 students registered in the Poultry-Course, three of whom were women; 13 were residents of New York State; one each came from Wisconsin, Minnesota, Iowa and Maine.

Nearly all, so far as we can judge from the data secured at the time of registration, came well prepared for their work, as the following statement will show: One had attended Syracuse University, one the Albany State Normal, one the Rhode Island State Agricultural College, one the Minnesota State Agricultural College, one

Cornell University (special one-year course), one was a graduate of a high school and business college, one a graduate of Trumansburg High School and had several years experience as teacher, one a high school graduate and several years experience as bookkeeper. Of the others, six reported high school training and the remaining three received district school education. Twelve had had farm training.

In age, the students ranged from 18 to 65 years. Four were over 30 years of age.

Of the six students who desired positions, all have been placed at salaries of $30 per month, including board and lodging, or better, with the exception of one, who could have been placed on these terms, but whom we did not dare recommend, owing to his inexperience and lack of farm training. This student has secured $20 per month, board and lodging. Of the students who did not take positions, four desired to take up poultry raising for themselves. Three others are women students, two of whom are continuing their work here, and one intending to continue the work another year. Another student is registered as a special and is pursuing work in poultry husbandry. The highest salary received is by the student who has charge of the poultry work in the Experiment Station in Minnesota. All of the others are in charge of poultry plants.

We have more requests for men to fill positions of responsibility than we have competent students to accept them. We have already been informed during the past year, either verbally or by correspondence, that the agricultural colleges or experiment stations in seven different States are anticipating establishing poultry departments in the near future.

Of the 17 students, six expressed an expectation of returning to Cornell for further instruction, of which poultry husbandry was to be a part.

At least 10 persons have already indicated their intention to take the Poultry-Course next year. It is safe to estimate that since the course began, we have received not less than 100 inquiries in regard to the work. It would appear perfectly safe to estimate that there will be more than twice as many students sign applications for the course next year as we had this year.

Following are courses of study offered in the three winter-courses of 1905:

A. *General Agricultural Winter-Course.*

All students in this course are required to take the following five subjects:

Fertility of the Land.—A study of soils from the chemical and physical point of view, with discussions on fertilizers, manures and the principles of plant growth. Lectures, 2 hours a week. Assistant Professor Cavanaugh and Professor Bonsteel.

Agronomy.—A study of field crops and farm management. As much time as possible is devoted to the culture of special crops; as corn, potatoes, wheat, oats, pastures and forage. Lectures and practice, 4 hours a week. Assistant Professor Stone.

Animal Husbandry.—Principles of breeding and feeding animals; history and development of animals, the care and management of dairy cattle. Lectures and practice, 3 hours a week. Professor Wing.

Horticulture.—Lectures on the principles of fruit growing and vegetable gardening, with practice in the propagation of plants, pruning, grafting, budding and spraying. Lectures and practice, 3 hours a week. Assistant Professor Fletcher.

The Farm Home.—Farm buildings; farm sanitation; planning and caring for the home grounds; the conveniences and comforts of the home; reading in the farm home. Lectures, 3 hours a week. Professor Bailey, Mrs. Comstock, Miss Van Rensselaer, Assistant Professor Fletcher and others.

A series of special lectures will be given by various members of the university faculty, and by prominent men from elsewhere who are authorities on certain lines of agriculture. Students in the General Agriculture-Course are required to attend these lectures.

In the General Agriculture-Course there are thus 15 hours a week of required work. Three hours of elective work may be chosen from the following subjects. No student may take more than 18 hours of work, excepting by special permission of the faculty, and 17 hours is as much as the average student can expect to carry satisfactorily.

Farm Botany.—A study of the principles of farm growth with particular reference to cultivated plants; the common fungous diseases of crops, and their control. Lecture and laboratory, 2 hours a week. Mr. Whetzel.

Economic Entomology. Lectures on insect pests of plant, orchard and garden, and remedies for them. Lectures, 2 hours a week. Assistant Professor Slingerland.

Farm Dairying.—Butter-making; the care of milk, and milk testing. Those who elect this course pay an additional fee of $5. Lectures and practice, 3 hours a week. Professor Pearson.

Poultry Husbandry.—A discussion of the domestic breeds of poultry; hatching and rearing; the principles of feeding and management. Lectures, 2 hours a week. Assistant Professor Rice.

Diseases of Farm Animals.—The common ailments of domestic animals, and their remedies. Lectures, 1 hour a week. Professor Law.

Farm Mechanics and Machinery.—Dynamometer and other tests of wagons and other farm implements; farm vehicles and machinery; road-building. Lectures and practice, 1 hour a week. Mr. Gilmore.

B. *Winter Dairy-Course.*

Instruction in this course is partly by lectures and recitations, but largely by actual practice in the different kinds of dairy work. The class assembles daily, except Sunday, at 8 a. m., and class room work continues two hours. The students are then assigned by sections or squads to different kinds of practice for most of the balance of the day. These assignments are made so that in the course of the term each student will have his fair proportion of work in each department.

Lectures are given in one-hour periods. Frequently they are replaced by examinations and often a part of the hour is occupied by informal discussion of previous lectures or topics previously assigned for study. The subjects of the different lecture-courses and the approximate number of hours given to each are as follows:

Milk and its Products.—This course is given from 8 to 9 a. m. daily from Monday to Friday throughout the term. It includes a full discussion of the secretion or formation of milk, its nature and composition, its care and preservation, different dairy products, conditions affecting their quality, methods of marketing, the business side of dairying, dairy mechanics, the construction of dairy buildings and the legal requirements applying to dairy products. Special attention is given to dairy bacteriology and dairy sanitation. The lectures are supplemented by references to dairy literature,—current periodicals, experiment station publications and books. Three hours a week. Professor Pearson and Mr. Truman.

Animal Husbandry.—Three lectures per week throughout the term. This subject includes the care and management of dairy cattle and the compounding and feeding of the most economical rations. Three hours a week. Professor Wing.

Dairy Chemistry.—The elementary principles of chemistry are explained with a view to enable the student to better understand the composition of dairy products and the chemical changes connected with and influencing certain dairy operations. Three hours per week, the first three weeks of the term. Mr. Troy.

Diseases of Farm Animals.—The most common diseases of dairy cattle are discussed and remedies explained. One lecture per week throughout the term. Professor Law.

General Agriculture.—Under this heading are included several brief courses of lectures upon subjects intimately related to dairy industry,—such as farm manures, commercial fertilizers and the improvement of the land by judicious cropping. Three hours per week, the last eight weeks of the term. Professor Hunt, Assistant Professor Stone and others.

The testing laboratory is fitted with all appliances necessary for making the usual quick tests of milk and its products, including lactometers and a variety of Babcock testers. Each student is expected to become familiar with the Babcock method of determining fat, the calculation of total solids and the more simple tests for preservatives and adulterations.

The creamery contains numerous styles of the apparatus found in a well-equipped commercial plant. The milk is received, weighed, sampled and separated, and the entire processes of cream ripening and churning are carried through in the most approved manner. Special attention is given to Pasteurization and the use of starters. Every step of the work is performed by students and under the close supervision of competent instructors.

Instruction is given in Cheddar cheese-making by an expert in the process. The cheese room is equipped with small vats, and cheese is made in each the same as in large factory vats. All the work is performed by students, and every step is carefully observed and reported by them on blank forms provided for the purpose.

The university operates a milk route and students are given practice in preparing and bottling milk and cream for retail trade. Quick and accurate methods for standardizing milk and cream are taught.

Each student is given one to three exercises per week in dairy mechanics and as often as possible these exercises are accompanied by a thorough drill in factory bookkeeping and common problems in arithmetic such as must be understood by everyone who is doing exact work in any branch of dairying. The mechanics include the care and use of the boiler and engine, lacing belts, computing sizes of pulleys and speeds of shafts, pipe fitting, soldering and a thorough study of the construction of different kinds of separators.

Upon the successful completion of the short dairy-course, a student may become an applicant for a certificate of proficiency under the following general terms and conditions:

"Persons who have passed one full term in attendance upon the Dairy-Course and have satisfactorily passed all of the examinations required of them, may become candidates for a Certificate of Proficiency in Dairy Industry.

"Such a candidate must spend one full season in work at an approved Creamery, cheese factory, market milk plant or dairy. He must report regularly, upon blanks furnished for the purpose, such information in regard to his factory as may be required, and he must hold his factory in readiness for inspection at any time.

"Upon satisfactorily completing these requirements a certificate will be granted; under certain conditions a longer period than a single season's work may be required."

C. *Winter Poultry-Course.*

In view of the rapid development of the poultry industry, and the large number of persons who are interested in this business, the facilities for poultry instruction and experimentation at the College of Agriculture have recently been enlarged and the subject has been given an assistant professorship.

The short course in poultry husbandry is offered this year for the first time. It is one of a number of special courses with which the College of Agriculture hopes to meet the needs of the young farmers of the state who have chosen a special line of agriculture for their life work. It is also intended to help meet the demand for trained poultrymen to take charge of poultry plants owned by others. While it is manifestly impossible to fully prepare for so exacting a business as poultry-keeping in eleven weeks, this course will give the student a long start in the right direction and will enable him to avoid many mistakes which he would make otherwise. While it is not necessary that a student in this course should have had previous experience with poultry, it is extremely desirable. Instruction in the Poultry-Course is given both by lectures and by practice, the practice occupying the larger part of the student's time.

All students in the Poultry-Course are required to take the following work:

General Poultry Lectures.—A discussion of all subjects of special interest to poultrymen: covering such topics as developing special poultry markets; preparing fowls for exhibition; poultry shows, their value and management; judging poultry by score cards and by comparison; recent developments in poultry breeding; incubating; feeding for egg and flesh production; dressing; marketing; caponizing; locating, planning and building poultry houses; diseases of poultry and their control; poultry parasites and how to combat them; the comparative anatomy of poultry; poultry physiology; the chemistry of poultry foods; embryology of the egg; special lectures on poultry diseases, such as roup, tuberculosis, black head; growing crops especially for poultry, etc. Lectures, 4 hours a week. Assistant Professor Rice.

Special Poultry Lectures.—From time to time, special lectures will be given to the Short-Course students by experts along certain lines of poultry husbandry. Lectures will also be given by other members of the faculty, on subjects bearing indirectly on poultry husbandry, as the culture of crops valuable for poultry. Lectures, 2 hours a week.

Poultry Practice.—Class and individual practice in planning and building poultry houses; the management of incubators and brooders; selecting fowls for mating; feeding; dressing, and all the practical details of managing a successful poultry plant. Each student will be assigned a special flock and will be expected to perform all the daily operations of its care, keeping an accurate account of the individual record of each fowl, cost of keep, gain or loss of weight, temperature of house, etc., giving him an opportunity to do all the various kinds of work about a poultry plant before he is called upon to do it for himself. He will operate an incubator, giving complete records of results obtained. Excursions to points of interest to poultrymen will be taken by the class occasionally. Three hours a week. Assistant Professor Rice.

The Farm Home.—Three hours a week. For description of this course see page 20.

There are thus 12 hours a week of required work in the Winter Poultry-Course. From the following list of subjects each student may, if it seems desirable, elect 6 hours more. All these elective courses, except the first one, are described under the General Agriculture-Course on the preceding pages. All students are strongly advised not to take more than 16 hours work. The selection of electives should be made after consultation with the professor in charge of the course.

Additional Poultry Practice.—For those persons who desire to get all the poultry experience possible in the limited time at their disposal, and especially for those who expect to take charge of a poultry plant immediately. Practice, 3 hours a week. Assistant Professor Rice.

Agronomy, 4 hours a week. See page 20.

Farm Dairying, 3 hours a week. See page 21.

Horticulture, 3 hours a week. See page 20.

Fertility of Land, 2 hours a week. See page 20.

Animal Husbandry, 3 hours a week. See page 20.

Diseases of Farm Animals, 1 hour a week. See page 21.

Farm Mechanics and Machinery, 1 hour a week. See page 21.

For instruction in poultry husbandry there are several poultry houses, having a capacity of 500 hens and 20 ducks; 11 styles of incubators; various types of brooders; several kinds of bone cutters; various charts and models; stereopticon slides for illustrating lectures; a collection of eggs, containing from two to four eggs of nearly all the varieties of domestic poultry. There is an incubator cellar 30 feet square; a slaughter house and packing room 16 by 20; a judging pavilion, feed room, root cellar and carpenter shop. All the standard poultry papers are on file in the dairy building, and the poultry library is one of the largest in the country.

A valuable feature of the Poultry-Course is the annual poultry show which is conducted by the students in this course. They carry on the correspondence, keep the records, prepare the fowls for exhibition, score them, award and receive prizes. Many poultrymen from elsewhere send their stock here for exhibition, to which, if deserving, the Cornell University Poultry Association ribbons are awarded. The show is judged by a well-known expert, whose score is used for comparison with the score of the students.

Those who qualify are given a limited certificate of proficiency, according to their ability to judge the various breeds.

Those who satisfactorily complete the Short Winter Poultry-Course receive a certificate to that effect, signed by the director of the College of Agriculture and the assistant professor of poultry husbandry.

ROSTER OF THE WINTER-COURSES, 1905.

Poultry Course.

Britten, O. E.	Syracuse, N. Y.
Buchanan, (Miss) S.	Cohoes, N. Y.
Hodges (Mrs.), L. R.	Flushing, N. Y.
Howell, C. W.	Cedar Rapids, Iowa.
Hunt, W. J.	Thorndike, Me.
Lain, C. H.	Westtown, N. Y.
Nixon (Miss), C.	Trumansburg, N. Y.
Opperman, C. L.	Burlingham, N. Y.
Phillips, E.	Oriskany Falls, N. Y.
Raynor, C. L.	Manorville, N. Y.
Robbins, E.	Burlington, Wis.
Seaman, George A.	Buffalo, N. Y.
Van Vleet, W.	Unionville, N. Y.
Walters, G.	Groton, N. Y.
Wilkins, S. D.	Minneapolis, Minn.
Wicker, W. G.	Ticonderoga, N. Y.
Wheelock, W. D.	Kennedy, N. Y.

GENERAL AGRICULTURAL-COURSE.

Agnew (Miss), K. N	3 E. 9th St., New York City.
Allnatt, G. S	Cherry Creek, N. Y., R. D. 35.
Artman, C. E	LeRoy, N. Y., R. D.
Ashman, B. A	Ridge Road, Greece, N. Y.
Bailey, J. A	Deposit, N. Y.
Barnum, E. E	Albion, N. Y., R. D. 6.
Barrus, M. F	Silver Creek, N. Y.
Blackmore, L. J	Akron, N. Y.
Booth, C. G	Ensenore, N. Y., R. D. 30.
Brand, R	Clyde, N. Y.
Britt, B. F	14 Grant St., Oxford, N. Y.
Brooks, R. J	Cortland, N. Y.
Brown, C. B	Groton, N. Y.
Burgin, J. H	Delhi, N. Y.
Chapman, E. L	Albion, N. Y., R. D. 4.
Cheney, Jr., M. A	Roanis P. O., Gloucester Co., Va.
Clark, W. H	New Berlin, N. Y., R. F. D.
Coe, W. N	Oswego, N. Y.
Coggshall, D. B	Groton, N. Y.
Cook, A. L	Cincinnatus, N. Y., R. D. 2.
Covill, J. B	Victor, N. Y.
Crowell, D. G	Vallkill, N. Y.
Davis, C. D	New Berlin, N. Y., R. D. 3.
Dean, H. W	Ithaca, N. Y.
Dey, Julia (Mrs. Charles)	Penn Yan, N. Y.
Dicker, W. J	Remsen, N. Y., R. D. 2.
Doty, W. A	Lockport, N. Y.
Driggs, C. H	Elba, N. Y., R. D. 2.
Dunkelberger, C. A	Gasport, N. Y., R. D. 40.
Dutton, W. W	Youngstown, N. Y.
Faulkner, W. J	Hornellsville, N. Y., R. D. 28.
Ford, J. F	German, N. Y.
Gettens, D. P	Mooers, N. Y.
Gillespie, A. M	Fulton, N. Y., R. F. D. 1, Whitaker.
Gillett, E. A	Franklin, N. Y.
Grannis, G. G	Clinton, N. Y., R. D. 2.
Greene, H. W	Fort Plain, N. Y., Main St.
Greene, C. E	McDonough, N. Y.
Grinnell, G. W	Elba, N. Y.
Harrington, F. R	McDonough, N. Y.
Harrison, F. L	Smithville Flats, N. Y.

Helfer, F	Naples, N. Y.
Herriman, H. H	Syracuse, N.Y., 316 W. Onondaga St.
Howard, E. S	LeRoy, N. Y., R. D. 28.
Howard, F. A	Morrisville, N. Y.
Hughes (Mrs.), A. E	Barneveld, N. Y., R. F. D. 2.
Irwin, J. E	Napanoch, N. Y., Box 92
King, H	Athens, N. Y.
Klemer, E. L	Faribault, Minn., 623 W. 3rd St.
Lathrop, H. N	Sherburne, N. Y.
Law, B. W	Ithaca, N. Y.
Law (Mrs.), B. W	Ithaca, N. Y.
Leonard, D. T	Delavan, N. Y., R. F. D. 2.
Lloyd, C. L	New Berlin, N. Y., R. D. 4.
Loring (Miss), F. R	Chicago, Ill., 2978 Prairie Ave.
Marsh, H. A	Dundee, N. Y., R. F. D.
Martin, C	E. Freetown, N. Y.
McEwen, J	Caledonia, N. Y., R. D.
Mekeel, C. O	Jacksonville, N. Y.
Merritt, S. L	Akron, N. Y.
Miller, W. H	Newark, N. Y., 7 Madison St.
Mills, D. J	Sandusky, N. Y.
Olin, H. A	Geneseo, N. Y., 22 Second St.
Onan, H	Willow Creek, N. Y.
Parrott, F. T	N. Y. City, 315 W. 94th St.
Patten, H. B	Albany, N. Y., 80 Dove St.
Phillips, W. G	E. Bloomfield, N. Y., R. D. 3.
Prole, G. A	Batavia, N. Y.
Purdy, C. E	Smithville Flats, N. Y.
Reed, E. N	Cortland, N. Y., R. D. 3
Ripley, L. A	Litchfield, Conn.
Rule, W. B	Madrid, N. Y.
Russel, E. B	Russia, N. Y.
Shank, R. C	Auburn, N. Y., R. D. 3.
Shaw, M. J	Kendall, N. Y., R. D. 29.
Sheldon, H. A	Geneseo, N. Y.
Sisson, M. B	Almond, N. Y., R. D. 1.
Smith, E. T	Brooklyn, N. Y., 217 Quary St.
Snow, A. T	Brooklyn, N. Y., R. D. 22.
Staub, J. F	Rochester, N. Y., 456 Hudson St.
Stephan, H. F	Bowmansville, N. Y., P. O. Lancaster, R. D. 1.
Terry, H	Southold, N. Y.

Thomson, C. W.	Andes, N. Y.
Underdown, W. E.	Trumansburg, N. Y.
VanHoesen, W. M.	Athens, N. Y., R. F. D.
Watson, R.	Lockport, N. Y., R. D. 7.
Webster, F.	Otsego, N. Y.
Wheeler, F. R.	Lockport, N. Y., 567 Locust St.
Whitaker (Miss), M. A.	Martinsburg, N. Y.
Wilcox, G.	Cherry Creek, N. Y.
Wilder, H. G.	Akron, N. Y.
Woolsey, R. D.	Tully, N. Y.

DAIRY-COURSE.

Allen, L. H.	East Homer, N. Y.
Allen, W. E.	Almond, N. Y.
Ambler, A.	Gloversville, N. Y.
Austin, H. E.	Whitesville, N. Y.
Baker, A. A.	Berkshire, N. Y.
Barrows, O. M.	McDonough, N. Y
Beardslee, C. E.	Willet, N. Y.
Beecher, L. A.	Hastings-on-Hudson, N. Y.
Bemiss, W. H.	Findley Lake, N. Y.
Blish, O.	Halcott Centre, N. Y.
Bogert, W. A.	Gouverneur, N. Y.
Bouton, G. H.	Virgil, N. Y.
Boutwell, H. G.	Copenhagen, N. Y.
Brown, F.	Cobleskill, N. Y.
Brown, L. L.	Skaneateles, N. Y.
Brush, T. R.	Arden, N. Y.
Caldwell, W. G. D.	E. Freetown, N. Y.
Carter, J. D.	Newfield, N. Y.
Collins, C. A.	Rossie, N. Y.
Conrad, L.	Marathon, N. Y.
Cottrell, J. E.	Scott, N. Y.
Cowls, A. D.	Lisbon, N. Y.
Crowe, F.	Owasco Lake, N. Y.
Cunningham, J. R.	Sherburne, N. Y.
Dugan, S. A.	Delhi, N. Y.
Eaton, G. C.	Willet, N. Y.
Fenner, F. B.	Lansingville, N. Y.
Finch, W. H.	Durham, N. Y.
Fitch, E. H.	Sidney Centre, N. Y.
Foord (Miss), B. D.	Kerhonkson, N. Y.

Forrester, E. A.	Lisbon, N. Y.
Fortin, E. F.	Saugerties, N. Y.
Fowler, R. C. H.	Moravia, N. Y.
Gordon, W. J.	Gloversville, N. Y.
Gutches, E.	East Homer, N. Y.
Haines, R. W.	Goshen, N. Y.
Hamilton, F. E.	Greene, N. Y.
Harter, G.	Otisco, N. Y.
Hartwell, F. S.	Crown Point, N. Y.
Hopkins, T. C.	Jacksonville, N. Y.
Horton, D. S.	New York City.
Hutt, C. M.	Gouverneur, N. Y.
Johnson, M.	Deerfield, N. Y.
Kiniry, J.	Fort Plain, N. Y.
Kitchen, C. W.	Arden, N. Y.
Lamb, J. A.	Jefferson, N. Y.
Lieber, G. E.	Spafford, N. Y.
Loan, C. H.	Lysander, N. Y.
Lohnes, E.	Valley Falls, N. Y.
Lyon, W. H.	Union Springs, N. Y.
Maginley, T. J.	Scottsburg, N. Y.
Manrow, G. C.	Port Byron, N. Y.
Meracle, W. L.	Rome, Pa.
Merry, H. S.	Verona, N. Y.
Mihalko, A. S.	Hobart, N. Y.
Millen, S.	Pawling, N. Y.
Miller, J. H.	Forestport, N. Y.
Moore, E. J.	Redwood, N. Y.
Murray, B. C.	New York City.
Neish, L. D.	Shavertown, N. Y.
Nichols, W. E.	Stockholm Centre, N. Y.
Northrop, H. J.	Freeville, N. Y.
Northrup, J. J.	Lisbon, N. Y.
Olmstead, J.	Sennett, N. Y.
Peabody, F.	Union, N. Y.
Portens, W. R.	Hobart, N. Y.
Ray, J. C.	Verbank, N. Y.
Russell, L. W.	Westford, N. Y.
Sage, N. K.	Avon, N. Y.
Sands, G. E.	Jordan, N. Y.
Scott, A.	Flackville, N. Y.
Sharp, H.	Forest Home, N. Y.

Sheldon, J. I.	Lisbon, N. Y.
Shimer, A.	Moravia, N. Y.
Sloan, C. N.	Clyde, N. Y.
Smith, J. A.	Oak Hill, N. Y.
Spencer, J. A.	Flat Creek, N. Y.
Sprowls, E. A.	Rensselaer Falls, N. Y.
Straw, H. D.	Guilford, Me.
Terpenning, H. A.	South Lansing, N. Y.
Thompson, W. E.	McDonough, N. Y.
Thomson, J. A.	Bovina Centre, N. Y.
Trescott, V. M.	Livonia, N. Y.
Turner, G. W.	S. Livonia, N. Y.
Wade, M. V.	Cortland, N. Y.
Walker, H.	Auburn, N. Y.
Walter, L. G.	Ketchumville, N. Y.
Ware, M.	Meridale, N. Y.
Wart, V. P.	Lacona, N. Y.
Webster, M. G.	Schenevus, N. Y.
Wells, L. R.	Rensselaer Falls, N. Y.

Respectfully submitted,

J. H. BAILEY,

Director of the College of Agriculture.

I. AGRONOMY.

1. FEDERAL EXPERIMENT STATION WORK.

The following is a list of the experiments conducted during 1905:

1. Timothy, 490 plats.
   - a. Selection and breeding work, about 20,000 individual plants in about 450 plats.
   - b. Rate of seeding experiment, 10 plats of $\frac{1}{10}$ acre each.
   - c. Influence of size of seed on yield, 7 plats of $\frac{1}{10}$ acre each.
   - d. Fertilizer trial, 23 plats of $\frac{1}{15}$ acre each.
2. Pasture Grass Experiments. Area 11 acres, divided into 22 main plats, each comprising 13 small plats, a total of 286.

   To determine the behavior of various grasses and clovers.
   - a. when sown alone.
   - b. when sown in various mixtures.

   To determine the effects of different fertilizers on these grasses.

   To study the root systems of these grasses.

3. Alfalfa.
    a. Selection and breeding work.
    b. Soil and inoculation trials in 100 plats.
4. Oats.
    a. Selection and breeding work.
    b. Rate of seeding trials.
    c. Cultivation trials.
5. Soy beans.
    a. Selection and breeding work.
    b. Trials of two varieties for forage.
    c. Trials with corn for silage.
6. Cow peas.
    a. Selection and breeding work.
    b. Trial of varieties for forage (co-operation with U. S. Department of Agriculture).
7. Potatoes.
    a. Selection and breeding work.
    b. Studies of quality.
    c. Spraying work.
    d. Influence of sprouting potatoes at various temperatures upon yield.
8. Root crops, 200 plats.
    Mangolds, half-sugar mangolds, sugar beets, parsnips, carrots, rutabagas, turnips, hybrid turnips, kohl rabi, cabbages.
    Objects—
    Test of varieties:
    To ascertain the yield of roots through a period of years.
    To compare the yield of dry matter per acre with that of corn.
    To note variations and select types considered suitable for this locality.
    To ascertain whether the specific gravity of the root and juice may be used for determining
    dry matter content,
    keeping quality,
    actual feeding value and
    used as an aid in selection.
9. Wheat.
    Trial of varieties on a specially adapted soil type.
10. Corn, 60 plats.
    a. Selection and breeding work.
    d. Trial of certain selected varieties for yield and forage purposes.

11. Rotation experiments.
12. Ginseng.
    Culture experiments.
13. Grass garden, 145 plats.
    Demonstration plats of grasses and clovers and used for experimental purposes.
14. Farm Mechanics.
    Trials of draft of implements.

The policy of the Department of Agronomy has been to continue the experiments previously begun and reported to you in my letter of May 26, 1904, and not to take up additional lines of work. Slight exceptions to this general policy may be noted as follows: No experiments are being made this season with field beans or buckwheat. Experiments with macaroni wheat have been replaced by an experiment with common wheat. Five years' culture experiments with sugar beets in co-operation with the United States Department of Agriculture were completed last year and the co-operative experiments with the bureau of plant industry, United States Department of Agriculture, in testing varieties of maize for northern latitudes have been begun. Experiments upon the influence of lime when applied to Dunkirk clay loam have been begun owing to a donation of a carload of lime by M. E. Reeder, Muncy, Pa.

As indicative of the character of the work and to show that it is on lines which are of considerable importance to the livestock interests of the state, attention may be directed to the number of plats under experiment.

Grasses and clovers, with alfalfa, 1,025 plats,
Root crops, 200 plats,
Corn, 60 plats,
Wheat, oats, soy beans, cow peas, etc., 100 plats,

or a total of 1,385 plats, almost all devoted to forage crops, out of a total of over 1,500 plats. The grass problem is so complex that it has not been considered an easy one to attack. It is important to the state, and by placing the experimental work on a broad basis, it is anticipated that results of some value will be obtained in the not distant future.

The following bulletins have been prepared by the Department of Agronomy during the year.

No. 228, Potato Growing in New York.

No. 230, Quality in Potatoes.

No. 232, Experiments on the Influence of Fertilizers upon the Yield of Timothy Hay when Grown on Dunkirk Clay Loam in Tompkins County, New York.

2. EXTENSION WORK.

The co-operative experiments in agronomy have been carried on during the past year along lines similar to those previously announced, though somewhat increased in variety and extent. The three main objects of the work as outlined by Professor J. L. Stone in his report herewith submitted are (1) to gain information in regard to the soil and crops under experiment, (2) to extend the educational influence of experiments to the farmers who are doing the work and to their neighbors who observe them, and (3) to promote closer relationship and better understanding between the farmers of the state and the College of Agriculture. I would add that a fourth result, if not an object, is in keeping the College of Agriculture in touch with the important problems of the state and the acquirement of information for the benefit of all citizens of the state. Much of this acquired information finds expression in personal letters to and personal contact with the people of the state. The extension work in agronomy has grown to such an extent as to impair somewhat, in my opinion, its efficiency. Hardly enough time and money is now expended to do the work as thoroughly as it should be done. It is too early in the present season to report the results of the extension work for this year. I am, however, presenting herewith the report by Professor Stone of the work in progress and have asked him to prepare for presentation to yourself a report upon the work for the season of 1904.

The work of the Department of Agronomy has been carried out by the following persons, to whose energy and devotion to duty I am glad to testify.

John L. Stone, Assistant Professor of Agronomy, who has charge of the extension work and the winter-course students in agronomy.

John W. Gilmore, Instructor in Agronomy, who has charge of the course in rural engineering and in farm practice, and who has general supervision of the farm business.

Samuel Fraser, Assistant Agronomist, who has charge of the experimental work.

George W. Tailby, foreman of the farm, who has immediate charge of executing all farm operations.

EXTENSION EXPERIMENTS IN AGRONOMY, 1904–1905.

REPORT OF ASSISTANT PROFESSOR J. L. STONE.

The co-operative experiments in agronomy carried on during the past year have been along lines similar to those of previous seasons, though somewhat increased in variety and extent. The three main objects of the work that have been kept steadily in view are:

1. To gain information in regard to the soil and crops experimented with. 2. To extend the educational influence of experiments both to the farmers doing the work and to their neighbors who observe them. 3. To promote closer relationship, and a better understanding between the farmers of the state and the College of Agriculture. Positive advantages are being made toward the attainment of each of these objects.

While perhaps little of the data obtained from these experiments may be classed as scientific and is hardly suitable for publication in bulletin form, yet to the farmers doing the work and to their neighbors it has a highly practical value. But of more importance than the gaining of a few facts is the establishment of the habit of asking questions of the soil and of the crops and watching carefully for the answers to those questions. The more complex and difficult the agricultural conditions become, the greater the necessity for habits of close observation. Experimentation cultivates such habits. Many farmers have been encouraged to undertake on their own farms the solution of problems of personal, practical interest to them. An effort is made to visit each experimenter during the season. These visits to the farms and the exchange of letters in connection with the experiments lead to the discussion of many subjects outside of the experiment that are of vital importance to the farmer. The farmer learns where he may obtain information bearing upon his problem, while the college gets a view of many questions from the farmer's standpoint and is better able to adapt its work to meet his needs.

As the farmers and institutions of the state having agricultural interests become more familiar with the college and its facilities for rendering them assistance, the college receives an increasing number of applications for personal visits to the farms that the problems may there be considered and the possible solutions suggested. Inasmuch as improved methods adopted by one farmer become the subject of observation and imitation by others, it is considered legitimate, so far as possible, to comply with these requests.

Investigations along the following lines are in progress, but as reports have been received at this writing from but a small portion of the experimenters, it is not possible to state conclusions.

Alfalfa.—A study of the adaptation of the soil and climate of New York to the growing of the crop. The experimenter to report the conditions existing, the manner of treating the crop and the successes and failures met in his experience. The direct experiments suggested were:

Seeding with and without a nurse crop;

Treating a portion of the area with lime;

Inoculation with cultures and soil;

Stable manure with and without inoculation.

Interest has seemed to center around the matter of inoculation. Packages containing inoculated and uninoculated seeds were sent to 200 farmers, and sacks of soil from our alfalfa field to 32 farmers. Many of the farmers introduced one or more of the other experiments into their plats—test of the effect of an application of lime being most frequent.

Oats.—A test of three varieties from selected seed. The varieties used were Board of Trade, secured in northeastern Pennsylvania; a strain of White Tartar, secured from the Winters farm in Tioga county, N. Y., and Kherson, a Russian variety imported and tested by the Nebraska Station, where it has proved very superior and from whom our seed was secured. Packages of the three varieties were sent to 12 farmers.

Fertilizers.—A test of nitrogen, phosphoric acid and potash, singly and in combination, eight plats 1-20 to 1-10 acre each. Eight farmers applied for this experiment.

Potatoes.—A variety test. Five pounds each of Commercial, Iona Seedling and Whitton's White Mammoth were sent to each of 54 farmers for this test.

Sunflower.—In corn for silage. Some farmers have reported very favorably in the past. Only four applied for seed this season.

Soy Beans.—Seeds of several varieties were furnished to 19 farmers, who were requested to report, so far as circumstances would permit, on

Their grain-producing qualities,

Their forage-producing qualities,

Their green-manurial qualities,

Their adaptation to growing in corn to improve the quality of silage, and

The effect of inoculating the seed with cultures. Part of the seed was inoculated for the last-mentioned test.

Field Beans.—A test of varieties. Sufficient seed for a test of Red Kidney, Yellow Eyes, White Marrows, Blue-pod Medium, Marrow pea and Excelsior pea beans was sent, upon request, to 20 farmers, who are to report upon their relative yield and adaptation to the localities where grown.

Buckwheat.—Ten farmers applied for and received sufficient seed of the Japanese and Silverhull buckwheats for a comparison of these varieties on their farms.

Vetch.—Four farmers expressed a desire to test hairy vetch as a cover crop when sown with rye, and were supplied with seed for the experiment.

The Destruction of Wild Mustard.—By means of press notices in some of the papers of the state 131 farmers were enrolled to test the efficiency of the copper sulphate spray in destroying wild mustard in growing crops. The heavy and persistent June rains that occurred soon after this work was started no doubt prevented many from carrying it to completion.

Liming Soils.—Aside from those who used lime in connection with their alfalfa experiments, five farmers have undertaken to make a test of the effect of lime on their soils and to report results.

Inoculation of Legumes.—Aside from those who are watching the effect of inoculation on alfalfa, seven farmers upon request were furnished a variety of legume seeds, part inoculated and part not inoculated, to observe the effect in the development of nodules and in the growth of the crop.

The renovation of pastures and meadows without plowing.—Two experimenters have undertaken to report upon the effect of sowing additional seeds upon pastures and meadows without replowing. Sometimes this treatment is accompanied with scarifying the surface or with applications of manure or fertilizer.

Dwarf milo.—Through the kindness of the United States Department of Agriculture the college was supplied with a quantity of seed of dwarf milo (*Andropogon sorghum var.*). This seed was distributed to 22 farmers who are expected to report as to its value as a forage crop in their localities.

Altogether 498 experiments were undertaken, distributed in 44 counties of the state and requiring the use of about 1,000 separate plats.

THOMAS F. HUNT,
Professor of Agronomy.

II. ANIMAL HUSBANDRY.

1. FEDERAL EXPERIMENT STATION WORK.

During the past year no new lines of work have been undertaken, but work has been continued along the same lines as formerly, namely, experiments in meat production with cattle, sheep and swine. Considerable data have been secured during the past year, but no results have as yet been published. Our work in the breeding and development of dairy cattle is continuous, and has progressed satisfactorily during the past year.

2. EXTENSION WORK.

Extension work in animal husbandry lines, with the exception of some half dozen lectures delivered at various points in the state has, been almost wholly devoted to the supervision of records of thoroughbred cattle. During the past year the records of 700 Holstein cows were supervised for various periods of time, mostly for seven days, but in many cases for 30 days, and in a few cases for longer periods. These 700 cows belong to 85 different owners in the state.

Of records for Guernsey breeders, we have visited regularly once each month and taken samples for fat determination, about 10 different herds, including between 40 and 50 different animals. The expense of this work, except the necessary clerical work in the office, has been borne by the different owners.

H. H. WING,
Professor of Animal Industry.

II-A. SUB-DEPARTMENT OF POULTRY HUSBANDRY.

A report of the work done in the Poultry Department for the fiscal year ending October 1, 1905, under the state appropriation is here submitted:

Instruction.—Two courses of lectures in Poultry Husbandry were given to the students in the winter-courses. One of these consisted of two lectures per week which was given to 30 students in the course in general agriculture. The other was a course of 55 lectures delivered to the students in the Winter Poultry-Course.

The Winter-Course in Poultry Husbandry, which was offered this year for the first time, was satisfactory both from the point of attendance and quality of the students.

Seventeen students were enrolled. Of these, three were women; 13 were residents of New York State, one Minnesota, one Wisconsin, one Maine, one Iowa. The large number of students proportionately from other states is worthy of note. This no doubt is due to the fact that only two other states offer systematic instruction in poultry husbandry, and these two offer courses of only six weeks each.

The course of instruction given consisted of 94 lectures, 55 of which were given by the writer, on subjects relating to the practical management of poultry, and the others as follows, from various departments and colleges of the university:

Prof. H. H. Wing, 10 lectures, "Principles of Breeding Poultry;" Dr. W. B. Mack, six lectures, "Diseases of Poultry;" Prof. S. H. Gage, six lectures, "Embryology of the Egg;" Dr. James Law, three lectures, "Internal Poultry Parasites;" Dr. G. S. Hopkins, two lectures, "Comparative Anatomy of Poultry;" Dr. P. A. Fish, one lecture, "Comparative Physiology of Poultry;" Prof. G. Cavanaugh, one lecture, "Condimental Poultry Foods."

Non-resident lectures were also given, as follows:

T. E. Orr, Beaver, Pa., three lectures, "Scoring and Judging Poultry;" T. F. McGrew, Washington, D. C., four lectures, "Turkeys, Squabs, Fitting Fowls for the Show, Scoring and Judging Poultry;" E. G. Wyckoff, Ithaca, N. Y., one lecture, "Making of a Breed;" Dr. E. M. Santee, Cortland, N. Y., one lecture, "Poultry Sanitation."

The fact that we are able to secure the services of so many experts from various departments and colleges of the university makes it possible to give a course of unusual strength—an advantage which is clearly due to the fact that the College of Agriculture is an integral part of a great university.

The instruction was about equally divided between the lectures and the practice work. Three afternoons per week and a portion of every morning, noon and evening, were devoted to the actual work of the poultry plant and to laboratory exercises of a practical nature. In addition to this, several extended excursions were made to points of interest to poultrymen and much time was devoted to the holding of the Annual Poultry Show. This, the second Annual Poultry Show, had more exhibits, larger attendance, and was of greater educational value even than the one of last year. This method of stimulating interest, imparting instruction and unifying student effort, appears to have proven its value and to have established itself as a fixed annual event.

During the summer a letter was sent to each of the persons who took the winter Poultry-Course with a hope in view of learning what benefit they had received from taking the Poultry-Course. Replies have been received from 15 of the 17 members of the class. The answers are gratifying in the extreme. Of the six students who desired positions, all were satisfactorily placed. All report that they are satisfied with their places and all appear to be giving satisfaction. One has had his salary raised. All are receiving higher salaries than they did before they took the Poultry Course. One person reports "$2\frac{2}{3}$ higher salary," one "$150 a year better." From the replies received it is safe to say that any persons having the natural qualifications for success with poultry can secure a salary enough larger the first year after completing the Poultry-Course to more than pay for the entire expense of taking the course. From the reports received it would appear that an equal financial advantage would also apply to those who undertake poultry raising for themselves. The demand for our students to take places of responsibility as managers of commercial poultry plants or those at agricultural colleges or experiment stations, is greater than we have students to supply.

The Reading-Courses.—During the year reading-course work in poultry husbandry has been conducted for the Reading-Course Bureau. I am informed by the supervisor of extension work that the records show that 1,483 persons in this state have received these lessons.

In addition to this, three of a series of 20 short stories about poultry, for children, have been prepared and published by the *Cornell Junior Naturalist Monthly*.

The amount of correspondence that comes to this office is very large and is increasing. This is due to the many ways in which we reach the farmers and village people, both old and young, nearly all of whom are in some degree interested in poultry.

Experimentation.—A large amount of data has been secured during the past two years on a wide variety of problems of interest to poultrymen. Two bulletins will soon be ready for publication from this department. The principal problems which have been or are now under investigation, may be mentioned, as follows:

"Comparative influence of a very warm, close pen and an open-air pen on the health, productivity and fertility of fowls;" "Comparative influence of a glass or all cloth windows on the lightness, dryness, temperature and purity of the air of poultry houses, and the consequent effect upon the health, growth, and egg production of fowls;" "Influence of alfalfa pasturage and other green food on egg production, the health of fowls and the fertility of eggs;" "Comparative anatomy of the various breeds of poultry to determine type differences;" "Investigation to work out the life history of two species of external poultry parasites, and best methods of destroying them;" "The function of meat in the economy of digestion of the domestic fowl;" "A comparison of the value of the systems of wet and dry feeding for egg production;" "How much food should be fed all other conditions being equal, for best results in egg production;" "The comparative value for egg production of a ration of all whole grain without meat, and a ration containing both whole grain and meat, and their effect on fertility of eggs and vitality of germs;" "The comparative value of meat scraps, green cut bone and milk flour for winter egg production;" "Changes in temperature reading in incubators due to the position of the thermometer;" "A comparative test of several of the most modern devices of incubators;" "Influence of high and low temperatures on the developing germ;" "The effect of moist air as compared to dry air in incubators at the time of hatching;" "A comparison of the natural and artificial methods of incubation."

Development.—During the year the equipment of the poultry department has been materially enlarged to meet the needs of the increased number of students and the necessity for investigation of many poultry problems. The main poultry building has been completed. Several additional varieties of fowls and ducks have been added to the stock, which now numbers approximately 500 fowls and 30 ducks, representing 17 varieties.

On the whole, the poultry department, while not as large and as well equipped as it should be in order to accomplish the best results, is nevertheless on an effective working basis.

JAMES E. RICE,
Assistant Professor of Poultry Husbandry.

III. HORTICULTURE.

1. FEDERAL EXPERIMENT STATION.

The work of the Horticultural Department in the Federal Experiment Station may be outlined as follows:

(a) *Propagation of the Sour Cherry.*—This subject has been investigated by an advanced student of the department and some valuable results secured.

(b) The experiments announced last year in shading plants have been continued under glass and in the field.

(c) Whether acetylene light is to be a factor in the forcing of plants, is a problem which has been under investigation for the past two winter seasons and is being continued. The subject is also being studied in its relation to modification of the structure of the plant.

(d) A study of the oriental pears and their hybrids in relation to adaptation and commercial value, has been under way for some time and a bulletin is promised during the year.

(e) Among minor investigations are tests of the newer vegetables, the forcing of strawberries and greenhouse crops.

2. EXTENSION WORK.

(a) *Orchard survey.*—This work was continued in Niagara county during the summer of 1905. Owing to the lack of any appropriation under which it could be conducted, the area covered was relatively small. The services of graduate students of the department were used advantageously, and a preliminary report is in course of preparation. The peach in addition to the apple was studied.

(b) *The investigation of horticultural industries.*—The culture of the grape is a leading industry in several lake districts in New York. It has suffered severely in recent years from root-killing and epidemics of fungous diseases. The department has collected information of value, which, it is hoped, will be presented in bulletin form before long. Garden beans have been studied from two standpoints, the commercial aspect and the varietal characteristics. Careful studies of these features have been made at home and abroad.

(c) *Extension teaching in the State.*—Addresses have been given at granges, farmers' clubs and institutes by special request of these organizations as time permitted. Much interest has been manifested in the various phases of civic improvement by town and village societies. A number of addresses have been given, committees have been met and conferences held for the purpose of assisting in the aesthetic improvement of the exterior of houses in the smaller towns and villages. In passing, it is appropriate to note that each year records increased interest on the part of the farmer in the surroundings of his home. In the rural districts more shrubs are being planted, more lawn is being cared for than ever before. An interesting type of meeting that should be assisted and stimulated is the field meeting where farmers gather to study and examine the crops on the ground.

(d) *Extension teaching at the university.*—A course of lectures was given in 1905 to winter-course students in agriculture on commercial fruit-growing. There has been a continuously increasing demand for special winter-course instruction in horticulture. This we have tried to meet in an improvised manner by arranging a course in fruit-growing, vegetable-gardening and floriculture for the winter of 1906.

3. PUBLICATIONS.

Three bulletins have been issued during the year. Two of them were prepared under the direction of the horticulturist by G. F. Warren, a student of the graduate school taking major work in horticulture, and gave the results of an exhaustive study of the apple industry of Wayne and Orleans counties. The first, that of Wayne county, comprised 183 pages; the second, Orleans county, 42 pages. Both of these have been much appreciated by fruit-growers in these counties, and in other parts of the state. There is a demand for further investigation of this nature. The third bulletin gave the results of experience and experiments in growing some of the leading forcing-house crops.

JOHN CRAIG,
Professor of Horticulture.

IV. ENTOMOLOGY.

I herewith transmit a report on the entomological work of the Station during the past year under the auspices of the State fund. The report has been prepared by the assistant entomologist at my request, as nearly all the entomological work has been done by him.

J. H. COMSTOCK,
Professor of Entomology

REPORT OF ASSISTANT PROFESSOR SLINGERLAND.

The work of the Entomological Division of the Station during the past year has been concentrated along a few important lines. Some of the work begun last year has been finished, and considerable new work has been done, or is now in progress. Co-operative spraying experiments were continued with several prominent fruit-growers and some valuable results obtained. The life-histories of some new and important shade-tree pests have been worked out. Much time has been consumed in teaching and correspondence work.

1. FEDERAL EXPERIMENT STATION WORK.

The study of the grape-berry moth was completed, and resulted in much new information regarding its habits, life-history and remedial suggestions. I was able to demonstrate that this pest is an American insect and not a European species, as we have always supposed. It was also found that other similar insects, which had been classified with this grape-berry moth, but which fed on different food plants, were distinct species. One of these allied forms, and also the most common parasitic enemy of the grape-berry moth, were described by experts as new species, and both were named "Slingerlandana." This important work on one of the serious pests of the grape was published as Bulletin No. 223, The Grape-berry Moth.

Work on the life-histories of two comparatively new shade-tree pests was completed and a practicable and effective method of combating them was found and tested. Both these insects are sawfly leaf-miners, one working on the European elms, and the other on European alder. They have been quite destructive to the shade-trees on the university campus and in various parts of the state. In connection with these shade-tree pests, I have also studied the bronze birch borer. This insect has wrought great destruction in the parks and on private grounds in several of our large cities, and it is fast killing the white birches on the university campus and in Ithaca. These investigations will be brought together in a bulletin to be issued during the coming year.

2. EXTENSION WORK.

The extension of the entomological division under the state appropriation has been rather miscellaneous and of a more popular character.

Teaching.—During the winter I gave a course of lectures on injurious insects, one lecture each week, to 40 students in the winter-course.

Experimental work.—There was issued from this division Bulletin No. 224, Two Grape Pests:

I. Effective Spraying for the Grape Root-worm.

II. A New Grape Enemy: The Grape Blossom-bud Gnat.

The junior author of this bulletin, Mr. Fred Johnson, rendered very valuable services in the work on grape pests during the season.

Although my experiments during the preceding two years indicated that the arsenate of lead spray was effective against the grape root-worm, it was decided to continue the experiment another season to more fully corroborate our work, and demonstrate the value of this method of fighting such a serious pest. The same nine-acre vineyard that was sprayed last year was again sprayed with this same poison this season. Two applications were thoroughly made by a student assistant, Mr. R. S. Woglum, with the result that it was difficult to find any eggs laid by the beetles on the vines that were sprayed. In connection with this work on the grape root-worm, I discovered that its enemies are now taking an active part in the warfare against it. In examining one vine at random in an infested vineyard, I found 11 egg-clusters of this pest. In at least three of these egg-clusters every egg contained a minute parasitic fly instead of the embryo grape root-worm. This little enemy proved to be one of the parasites which did gallant work in Ohio vineyards several years ago. It is known as *Fidiobia flavipes.* As it lives in the eggs there is no danger of checking its goodly work with any of the treatments for controlling the pest by man. While I believe this parasite will be an important factor in reducing the numbers of grape root-worms below the danger limit in the Chautauqua grape region, I would not advise any vineyardists to wait for its appearance or to let up a particle in their warfare of cultivation and spraying for the pest. Nature's insecticides are usually very effective in the long run, but oftentimes too slow for man who is dependent on annual crops.

Co-operative experiments.—This division purchased 650 pounds of arsenate of lead for co-operative experiments with fruit-growers during the season. About 400 pounds were used in spraying for the grape root-worm in Chautauqua county, the results of which have been given above.

Six prominent fruit-growers co-operated in spraying with this poison for the plum curculio. Some obtained quite marked results, while others could see little difference between sprayed and unsprayed trees. Several plum-growers, however, are convinced that they can control this pest by judicious applications of a poison spray just after the petals have fallen and again a week or ten days later. It requires very thorough and timely work.

Two orchardists used this poison under my directions for the quince curculio. The results were not so marked as last year, and in one case they were vitiated by the jarring of the sprayed trees with a "curculio-catcher."

Last year's experiments against the rose-chafer were continued this season. Two rose-growers and one vineyardist used the arsenate of lead spray, and my assistant, Mr. Woglum, also sprayed some roses. The insect appeared in large numbers over a wide territory in the region along the southern shore of Lake Ontario, and in isolated places in other parts of the state. In my spraying experiment the rose foliage was almost completely protected from the attacks of the beetles by only one very thorough application of the poison, which was used at the rate of 12 pounds in 50 gallons of water. An extensive rose-grower on Long Island, who sprayed twice with the poison at the rate of 10 pounds in 50 gallons of water reports that "The bugs distinctly avoided the sprayed beds and rows. If caught and placed on the sprayed parts, they would become sluggish in their movements, and paralyzed in their limbs, and many of them would die."

Work was continued on the life-history of the rose-chafer and a bulletin is in preparation giving the results of our studies on this insect, and of the co-operative experiments with a poison spray to control it. In this bulletin we also expect to include the results of the co-operative work against the plum and quince curculios.

I visited several of the orchardists who carried on co-operative experiments, both before spraying time and afterwards, to note the results. In these visitations among the farmers, I learn much that is helpful to me in a practical way, and often I am able to give direct information that is of much benefit to them.

During a recent tour through many of the best fruit orchards in the western part of the state, I discovered that the dreaded San José scale was thoroughly established in several orchards where the owner hardly suspected its presence. This serious orchard pest is now widely scattered all through the state, and is cropping out in new localities at frequent intervals. Evidently all our orchardists must sooner or later face the problem of controlling this dangerous enemy. I am just starting a series of experiments with the new soluble petroleums against this scale insect. These preparations make staple emulsions by simply diluting with water. Some preliminary experiments give very promising results.

M. V. SLINGERLAND,
Assistant Professor of Entomology.

V. AGRICULTURAL CHEMISTRY.

1. FEDERAL EXPERIMENT STATION WORK.

In continuation of the experiments of the previous year, 59 samples of sweet corn have been examined for the sugar content. The results of the first year's work indicate that the sugar content may be increased, by proper selection of seed, as individual ears showed sugar contents ranging from 3.47 per cent. to 6.28 per cent. (dry basis). The work will be continued.

The Department of Agronomy is endeavoring to grow some easily digested food of proper composition to take the place of western grains and by-products. In this connection, analyses have been made of 87 samples of cabbage and root crops. There have also been examined for this department, 112 samples of soils and eight samples of potatoes.

2. EXTENSION WORK.

In response to requests from various sections of the state, analyses have been made of nine samples of lime, eight samples fertilizers, 18 samples feeds, three samples soil and two samples weed destroyer. Analyses of 17 samples of apples were made for the department of horticulture in connection with the orchard survey of Wayne county.

3. WORK IN PROGRESS.

This Department is co-operating with the Department of Agronomy in soil and inoculation experiments with alfalfa in an effort to correlate the amounts of soluble plant food of the soil with the differences in growth of this crop.

During the year, a study will also be made of the conditions under which the oat crop has failed in different parts of the state.

GEO. W. CAVANAUGH,
Assistant Professor of Chemistry in its Relations with Agriculture.
JAS. A. BIZZELL,
Assistant Chemist to the Experiment Station.

VI. BOTANY.

I present herewith the annual report of the Botanical Division of the Federal Experiment Station for the year ending June 30, 1905.

CULTURE OF MUSHROOMS.

Some investigations have been carried on for the purpose of determining conditions for growing mushrooms in a simple way, in cellars or basements of buildings, and under benches in greenhouses. The results the past year were very successful and a large yield for the space occupied was obtained under benches in the greenhouse connected with the department of botany and in the basement of the building. The mushrooms were also of excellent quality. An account of these experiments was published as Bulletin No. 227, Mushroom Growing for Amateurs, March, 1905.

It is planned to continue these experiments in a small way and extend them as far as possible with the facilities now at our disposal to other species closely related to the common mushroom.

STUDIES OF THE HIGHER FUNGI.

The study of the higher fungi which has been one of the special features of the work of the Botanical Division has been continued with the result that considerable additions have been made in the way of illustrations and notes for monographic work on some of the more important genera which it is hoped may be prepared for publication sometime in the future. The studies serve for the present a very valuable purpose in giving us the basis for supplying information to a large number of correspondents who write for aid in determination of species and for information as to the edible or non-edible character of these plants, and concerning the disease of fruit, shade and forest trees.

RESEARCH WORK.

Considerable attention is given to research work on problems of a more scientific nature which serve one way or another as the basis of applied science, for the instruction of our constituents and for the general advancement of knowledge.

1. One of these problems has been the study of the embryology and development of *Agaricus campestris*, the common mushroom. This study has been completed. It comprises the determination of the origin and differentiation of the different parts of the plant in the embryo stage from the simple mass of undifferentiated tissue at the time the minute fruit bodies first appear on the strands of mycelium. The study has been made with sections in paraffin which have been prepared and stained in accordance with the best methods. Photomicrographs have been made of the different stages of development. The study will soon be prepared for publication, either as a bulletin or as an article in some scientific periodical.

2. Some progress has been made in the investigations started for the purpose of determining whether the substance of the fleshy fungi possess any food value for the higher plants after decay. The experiments thus far have been conducted with the common mushroom, *Agaricus campestris*, which has been employed as the sole source of food for corn, beans, peas and buckwheat. These preliminary experiments show that during the early stages of decay the mushroom exercises a distinct poisonous effect on the seedlings, but after decomposition is far advanced the plants recover from the injuries if

the mushroom substance is properly "diluted" with sterile sand and the plants make a more healthy growth and more increase in plant substance than those grown in sterile sand alone. These experiments will be continued.

3. Investigations have been started to determine the life-history of several parasitic fungi affecting fruits and vegetables for the primary purpose of determining the perfect stage of development and the manner in which the fungi exist during the winter.

GENERAL WORK.

Aside from the special problems for investigation there is a great deal of work which is of a general character. This consists of observations, notes, photographs, etc., of a great variety of plant diseases caused by fungi. The work is done for the purpose of accumulating data which will be of value in replying to the numerous calls for information which are received and also will serve in many cases as the basis or aid in some future piece of investigation. Much time is also required to attend to the large correspondence, to determine plants sent in for determination, to name fungi and fungus diseases, and to recommend methods of treatment for fungus diseases, etc., etc.

I would also call your attention again to the need of a special building for the study of plant diseases as outlined in my last report.

EXTENSION WORK.

This work has been prosecuted with unusual vigor and success by the plant pathologist, Mr. H. H. Whetzel, whose report is given here for the year ending September 30, 1905 (comprising remainder of this report):

The following is a brief statement of the chief lines of investigation carried on during the year.

1. *Blight canker of apple trees.*—Investigation into the nature and cause of certain cankers of young apple trees was begun in the autumn of 1904 and has been continued up to the present time. A very large proportion of the time and funds at the disposal of the pathologist have been devoted to the investigation of this disease. The work has consisted of trips to various parts of the state where the disease was known to be prevalent and severe, for the purpose of studying the trouble in the field. An orchard of 350 apple trees near Ithaca known to be slightly affected has been visited weekly, and a careful record of the condition of each tree made every two weeks with the object of collecting data on the different stages in the progress of the disease, methods of dissemination, susceptibility of varieties, etc.

Various methods of treating diseased trees were also being tried in this and other orchards. Three complete sets of inoculations, consisting of ten or more individual infections each, have been made during the past season. Five or more pure cultures of the organism from cankers on apple trees, blighted twigs of apples and pears, and blighted fruits of both apples and pears, have been obtained and tested in various culture media to determine their identity. Over 100 photographs of various forms and stages of the canker and twig blight have been obtained. Extensive and detailed data in the shape of notes, correspondence, etc., have been gathered. A paper prepared on the subject, and illustrated with some 30 lantern slides, was presented before the American Pomological Society in session at Kansas City, September 19–21, 1905.

Briefly the following conclusions may be drawn from the year's work:

a. The disease is quite prevalent and destructive throughout central New York, the Hudson Valley region north of Albany and in the extreme northern part of the state about Chaumont. It is also reported from the southern part of the state.

b. Trees of from six to 15 years of age suffer worst from this malady. Of the young orchards just coming into bearing in the Hudson River region fully 95 per cent. are badly affected. Old trees also suffer frequently.

c. The cankers have been proven to be due to bacteria and successful inoculations into the healthy bodies of pear and apple trees have been made, resulting in well developed cankers.

d. By cross inoculations both direct and from pure cultures, the twig blight of pears and apples, and these cankers on apple trees as well as the "Body Blight" of pears have been proven to be due to the same organism, *Bacillus amylovorus*. The testing of pure cultures of the organisms obtained from these different sources, through some 10 or more different culture media, has shown them to be the same.

e. The chief methods of infection seem to be: through water-sprouts on limbs or body, wounds, pruning knife, or insects that follow to suck up exuding sap and boring insects, e. g., borers, etc.

f. The high per cent. of deaths of trees in certain regions seems to be due largely to the work of secondary fungi and bacteria that gain entrance through the infection courts provided by the cankers and cause heart rot of the tree.

g. Slightly affected trees may be successfully treated as follows: cut out all diseased or cankered tissue, swab out with a two-tenths per cent. solution of corrosive sublimate or a three per cent. solution of copper sulphate and paint over with some heavy paint. Actively spreading cankers may be checked by simply cutting out the diseased bark and allowing the wound to dry. It should be painted later to prevent the entrance of rot fungi.

h. Cultivation increases the susceptibility of apple trees to this disease.

i. Certain varieties are more susceptible than others. Only one was found that was entirely immune, that was the Wolf River. Talman Sweets are quite resistant. Baldwins and Ben Davis are most susceptible and the first to go out.

While the cause of this disease seems to be well established, there still remains much important work to be done in the way of verifying certain conclusions by more extended observations, the duplicating of some of the inoculations, the determination of conditions most favorable to the development of this disease on the bodies of the trees, susceptibility of varieties, relation to "collar rot," etc., and the relation of certain phenomena, such as, bleeding, etc., to this disease. A continuation of the work along these lines is planned for next year. It is also planned to undertake some investigations into the means by which this disease is disseminated to the twigs and water sprouts resulting in twig blight.

2. *Diseases of Ginseng.*—This investigation is a continuation of the work begun by Mr. Van Hook in 1903. Practically all our work along this line during the past season has been devoted to a study of the leaf blight of ginseng.

Leaf Blight.—This disease is by far the most widespread with which the grower has to contend. The past rainy season has been especially favorable to its development, and losses from it have been heavy. It is due to a fungus, *Alternaria.* It attacks stem, leaves and fruit. In most cases it completely destroys the parts of the plants above ground. The roots are not affected and aside from a reduction in growth do not seem to suffer. They send up apparently as healthy stalks the year following a severe attack of the disease as they do following a year in which the tops have not gone down. The disease almost always ruins the seed crop. It is quite destructive to the foliage of seedlings, greatly reducing root growth. It is largely responsible for the "blasting" of seed even though the foliage may not suffer much. It has been demonstrated beyond question during the past season that it may be controlled entirely by the proper use of Bordeaux mixture. The disease was found on wild plants.

Through the courtesy of the Consolidated Ginseng Company of Rose Hill, N. Y., we have been able to study this disease in their gardens, and will with their co-operation conduct extensive experiments in the sterilization of the soil with formalin and steam for the control of this disease and the "tip rot" and damping off of seedlings. We are indebted to Dr. I. C. Curtiss of Fulton, N. Y., for extensive and successful experiments in spraying for this disease.

Numerous photographs and data in the shape of notes have been collected and short articles on this disease have been contributed to different ginseng publications during the year. Material is ready for a short bulletin on the Leaf Blight and Soft Rot of the Roots. Continued experiments in spraying and soil treatment are planned for next year.

Other diseases of Ginseng have also received considerable attention, among which is to be mentioned a blight of stems and leaves due to bacteria. The organism was isolated and inoculations made which resulted in successful infection.

3. *Alfalfa Leaf Spot.*—Spraying experiments to determine if this disease could be controlled were begun quite early in the season. Various mixtures were used and applied every week for several weeks until the alfalfa was too tall to make spraying of any value. Examination of the different plots at the time of the first cutting showed but little reduction of the leaf spot. Those plots treated with Bordeaux mixture seemed to show the least. The weather was very rainy, the plots treated were small and the work begun so late in the season that no conclusions can be drawn. It was planned to spray again after the first cutting, but continuous rains directly after the first cutting prevented the removal of the crops until the alfalfa had grown too tall to make spraying feasible. The work for this season was therefore dropped.

4. *Bean Diseases.*—The Bacterial Blight of Beans, and the Bean Anthracnose were very prevalent and destructive in certain sections during the season. A press bulletin on Bean Anthracnose was issued and distributed to bean growers of the state. A visit to one of the bean-growing sections was made and a talk on the subject of bean diseases given before the local grange. Extensive experiments in spraying for Anthracnose during the coming season are planned.

5. The correspondence for the past year has been very heavy. This has taken up a large part of the time when not in the field. The inquiries, while varied, have been largely with regard to diseases of fruit and shade trees and the diseases of truck crops. These have all been given prompt and careful attention. Numerous bulletins

and copies of the spray calendar have been sent out. We have carried a microscope with us constantly on our trips and have attempted to show the grower the organism that was causing him trouble and to explain to him its nature and the means of combating it. This plan has been highly satisfactory. Where possible we have made practical demonstrations of the explanations by inoculations in the field. This we believe has resulted in a more intelligent co-operation on the part of the grower in combating these diseases.

GEO. F. ATKINSON,
Professor of Botany.

VII. DAIRY INDUSTRY.

THE EXTENSION WORK.

For this work there was allotted from the State fund, $3,000. This has been expended as follows:

1. *Correspondence.*—It is estimated that about 2,000 letters were written last year in connection with extension work. Many inquiries are received from dairymen, butter-makers and cheese-makers who wish to have some difficulty explained and a large number of letters come from persons wishing to enter or ask about the Winter Dairy-Course. Every inquiry received is carefully answered.

2. *The Dairy School.*—As in previous years a winter-course was given in dairy industry. The term lasted 11 weeks, January to March. The size of the class was larger than ever before and taxed to the utmost our facilities for the winter-course instruction. Ninety-one students registered,—90 men and one woman, and these gave their entire time to instruction in dairy and closely allied subjects. Thirty-one students taking the General Agricultural winter-course elected farm dairying and received instruction in this subject in one lecture and two half days of practice each week. The ages of the 91 regular dairy students were from 18 to 48, the average being 25. They came from 30 counties in this state and two neighboring states (students from other states paid tuition) as follows:

Allegany county	2
Broome county	1
Cayuga county	7
Chautauqua county	1
Chenango county	4

Cortland county	9
Delaware county	7
Dutchess county	2
Essex county	1
Fulton county	2
Greene county	2
Jefferson county	1
Lewis county	1
Livingston county	4
Montgomery county	2
New York county	2
Orange county	3
Oneida county	3
Onondaga county	5
Oswego county	1
Otsego county	2
Ontario county	1
Rensselaer county	1
Schoharie county	2
Seneca county	1
St. Lawrence county	11
Tioga county	2
Tompkins county	6
Ulster county	3
Westchester county	1
Maine	1
Pennsylvania	1

Instruction in the Winter Dairy-Course is given largely by assistants engaged especially for this purpose. W. W. Hall was in charge of cheese practice and W. E. Griffith of creamery practice. Being officers of the State Department of Agriculture, they were detailed by the Commissioner of Agriculture, Hon. Charles A. Wieting. We paid their expenses while in Ithaca. H. C. Troy was in charge of the testing laboratory. He also is connected with the State Department of Agriculture and occupies a laboratory in the dairy building by courtesy of the University. The last named and one extra assistant in each of the three divisions named received nominal compensation. The assistants were selected from present or former students and regarded their connection with our work as of enough personal advantage to largely pay for their services.

Perhaps the value of the Dairy-Course can be best shown by quoting from those who took it. About the middle of the season each student who was registered in this course last winter was asked how his position compared as to responsibility and salary with his position one year earlier,—before taking the Dairy-Course. Most of the replies are given:

H. G. B., Lewis county, assistant in cheese factory.
"The responsibility is more than it was last year and the salary is the same."

W. H. F., Greene county, operator in skimming station.
"Salary is higher and there is a great deal of responsibility."

S. A. D., Delaware county, foreman of creamery.
"Responsibility is much larger and salary $15 per month gain."

A. D. C., Essex county, manager of creamery.
"Last year was second man at $35 per month. This year first man at $50 per month."

W. A. B., Essex county, cheese-maker.
"Responsibility greater and salary increased $8 a month."

C. E. B., Westchester county, helper in dairy.
"About the same responsibility this year as last year. Salary $24 per month and board."

W. E. A., Allegany county, butter and cheese-maker.
"Responsibility about the same as last year and one-third increase in salary."

L. H. A., Wyoming county, cheese-maker.
"My position this year is much better than it was last year and the responsibility is greater. My salary is $13 per month more than it was last year and do not have to work as many hours."

H. E. A., Allegany county, cheese-maker.
"My salary is the same as last year and responsibility greater,—am now a partner in the business."

O. M. B., Schoharie county, cheese-maker.
"More responsibility and more salary than last year."

O. B., Rensselaer county, butter-maker.
"Am head man this year. Receive $20 more a month."

G. H. B., Erie county, Pa., helper in cheese factory.
"My position is the same this year as last, salary is better and the responsibility is more than it was last year."

W. H. B., Erie county, Pa., manager of cheese factory.
"Was helper last year."

L. L. B., Clinton county, butter-maker.
"More responsibility and better salary, now getting $30 per month and board."

J. D. C., Tompkins county, farmer.
"Responsibility the same, salary more than doubled."

C. A. C., St. Lawrence county, cheese-maker.
"Salary and responsibility both increased."

J. R. C., Oneida county, manager of creamery.
"A great deal more responsibility and double the salary."

F. B. F., Tioga county, sanitary market milk, first assistant.
"More responsibility and more salary."

E. A. F., St. Lawrence county, in charge of skimming station.
"Salary is $20 better than it was a year ago."

E. F. F., Chenango county, head butter-maker.
"Position this year has more responsibility than last year, with an increase of 25 per cent. in salary."

R. C. H. F., Livingston county, cheese-maker.
"Much better."

W. J. G., Jr., Schoharie county, butter-maker.
"One year ago was second man for a creamery company at $30 per month. This year have full charge of the plant and receive $60 per month."

E. G., Cortland county, manager creamery.
"This year get $20 per month more than last and am in charge."

F. E. H., Chenango county, work in a butter and cheese factory.
"Responsibility and salary are a little more than last year."

G. E. L., Onondaga county, helper in creamery.
"Last year I was in a skimming station. This year my responsibility is greater, as I am in a creamery and have charge of separating, cream ripening and churning part of the time."

C. H. L., Oswego county, butter-maker and helper.
"My salary is $10 per month more than I received last year and responsibility is greater."

E. J. L., Onondaga county, second man in creamery.
"Responsibility is the same, salary is more."

W. H. L., Suffolk county, assistant butter-maker.
"More responsibility, same salary, but better prospects."

W. L. M., Rome, Pa., cheese-maker.
"More responsibility and a better salary."

A. S. M., Delaware county, operator of skimming station.
"More responsibility, salary increased $10 per month."

S. M., Broome county, foreman in milk-bottling plant.
"Responsibility is much greater this season and salary is $70 per month. It was $40 per month last year."

J. H. M., Essex county, manager of skimming station.
"Responsibility greater, salary better."

J. J. N., Middletown, Delaware, assistant foreman in creamery.
"Have more responsibility and get a better salary."

H. J. N., Schoharie county, first man in creamery.
"The responsibility is greater and my salary is larger by $15 per month."

F. H. P., Bradford county, Pa., butter-maker.
"One year ago salary was $20 per month and at present it is $32."

W. R. P., Columbia county, butter-maker.
"Responsibility about the same and an advance of about $10 per month in salary."

J. C. R., Kings county, superintendent of three market milk plants.
"Fifteen dollars per month better, salary $75 per month now."

L. W. R., Madison county, third man or helper in creamery.
"Salary is much larger."

A. S., St. Lawrence county, butter-maker.
"More responsibility and $8 a month more salary this year than last."

J. I. S., Clinton county, creamery operator.
"Responsibility greater and $15 a month increase in salary."

J. A. S., Greene county, first man in creamery.
"Last year I was manager of a skimming station at $50 per month. This year I am first man in creamery at $55 per month the whole year and helper furnished."

J. A. S., Erie county, butter-maker.
"More responsibility and increase in salary of $8 per month."

E. A. S., St. Lawrence county, second man in butter and cheese factory.
"Salary increased $6 per month."

H. A. T., Oswego county, butter-maker.
"The responsibility is much greater and the salary is more."

W. E. T., Chenango county, helper in creamery.
"Responsibility more and salary better."

J. A. T., Delaware county, manager of creamery.
"The responsibility is the same, the salary is $60 a year more."

G. W. T., Orange county, butter-maker.
"Salary $50 a month with full charge of creamery."

H. W., Onondaga county, helper in butter factory.
"Responsibility is greater than last year and salary is $10 more per month."

L. G. W., Sullivan county, butter-maker.
"Responsibility greater this season. Salary same, but expenses less."

M. W., Delaware county, manager of creamery.
"Responsibility double and wages increased from $40 to $60 per month."

L. R. W., Wayne county, cheese-maker.
"Greater responsibility and salary increased one-half."

M. V. W., Delaware county, helper in creamery.
"Greater responsibility and salary increased from $37 per month to $50."

V. M. T., Hartford, Conn., helper in market milk plant.
"Worked on farm last year. This year my salary is $55 per month."

M. G. W., Broome county, assistant butter-maker.
"First year in creamery work."

L. D. N., Delaware county, butter-maker.
"First creamery work. Salary $50 per month."

R. W. H., Steuben county, condensing operator.
"Responsibility and salary doubled."

J. M. J., Herkimer county, butter-maker.
"First year in creamery work. Salary $30 a month and board."

T. J. M., Livingston county, manager and butter-maker.
"Assistant one year ago, now receiving $550 per year and helper furnished."

W. G. D. C., Cortland county, in charge of milk station.
"Position same as last year."

H. D. S., Schenectady county, helper in market milk plant.
"Position much better than last year. I now have charge of engine and boiler, pasteurizer and separators."

It should be remembered that while some of the short-course students have had good common school training, the majority have never finished the common branches, or did so several years ago and are "rusty" in these subjects. The short courses are intended for such men, providing they want to learn thoroughly the practical side of their work and as much as possible of the theory.

Prospective students are always advised to gain some experience in a cheese or butter factory or a milk shipping station before coming here. But sometimes this is impracticable and a student is admitted without previous experience. That such a one may succeed in a responsible position is shown by the following description of "A Model Cheese Factory," which was visited last summer by the instructor in cheese-making. The operator of the factory never made cheese before he entered the Short Dairy-Course in January, 1905.

A MODEL CHEESE FACTORY.

This factory is located in Schoharie county. The plant is new and excellent drainage has been provided. The floor is made of cement and the equipment throughout is of the best, including a continuously-pressing steel press and a galvanized iron whey vat. Payments to patrons for milk are based upon the most up-to-date method. They depend upon the fat contained in the milk and not upon weight of milk alone, as is the common practice. The average test of milk is 4.7 per cent. fat, and it requires less than nine pounds of this milk to make one pound of cured cheese. The factory man gets $1.20 per hundred pounds for manufacturing and furnishing, and the milk nets the patrons an average of $1.18 per hundred pounds when cheese sells for 11½ cents per pound, as they are selling at the time this report is made out.

The patrons have learned to value clean whey as a stock food. Accordingly the whey vat, which is placed on the floor above the working room, receives the same care as the vat in which cheese are made. The whey is delivered to the patrons in nearly as good condition as is the milk when received. A careful feeder estimates its value at 12 cents per 100 pounds when fed to swine. It is distributed to the patrons through an automatic weighing machine, which apportions it according to the amount of milk the different persons deliver.

The cheese are made by the most improved methods known in the American cheese-making districts. They are uniform in quality, firm and solid in texture, and they develop a high and delicious flavor when allowed to age.

3. *Inspections.*—During the season 108 visits were made at the factories of previous Dairy-Course students in different parts of the state. This part of the work is considered an important supplement to the Short Dairy-Course. It is carried on primarily to ascertain if

candidates for certificates of proficiency in dairy industry are doing really highgrade work and thus showing themselves worthy of special recognition. Most of these visits were made by Mr. W. W. Hall, cheese instructor. Some were made by other members of the instructing staff.

4. *Experiments.*—With the assistance of Walter E. King of the department of bacteriology of the New York State Veterinary College, the writer completed a series of experiments last summer upon the sources of milk contamination. Some valuable results were obtained. A few of the experiments need to be repeated and a few new ones carried through, when all results should be published.

On account of limited facilities some experiments upon butter and cheese making have had to be temporarily discontinued. They will be resumed in the near future.

5. *Attending meetings.*—The writer and Mr. Hall have attended and addressed several meetings held in the interest of better milk.

GENERAL.

1. *New Building.*—During the past year a very large amount of the time of the writer and some of his assistants has been demanded by the planning and construction of the new dairy building. In general plan this building differs markedly from the one in use the past 12 years and the dairy buildings at other agricultural colleges. Being in two distinct parts,—a one-story part for manufacturing work and a higher part for laboratories, class and lecture rooms, reading room, museum and offices,—one kind of work cannot interfere with the other, yet both may go on in conjunction as readily as when one is directly above or below the other.

2. *Milk Supply.*—Arrangements have now been completed by which the university will lease a small creamery near Ithaca and thus secure a supply of milk throughout the entire year. This will be advantageous in several ways. It will

(a) permit giving instruction in practical work at any time in the year.

(b) afford a better opportunity for experimental work.

(c) provide some milk for the winter dairy classes at a more reasonable rate than heretofore paid.

(d) enable the department to make butter throughout the year, thus holding a desirable trade.

R. A. PEARSON,
Professor of Dairy Industry.

VIII. NATURE-STUDY.

I would most respectfully submit the following report of results in the Bureau of Nature-Study for the school year ending June, 1905.

Total number of Junior Naturalist Clubs organized and under our care	486
Of this number those working under charter of previous years	229
Of this number those working under new charter	245
Those out of the state accepted on professional courtesy	12
Total membership of 486 Junior Naturalist Clubs, pupils of public schools	14,318
Total number of letters received from pupils relating to subjects suggested	33,833
Total number of pages mailed to members of Junior Naturalist Clubs	781,400
Number of topics treated during the school year	50

SUBJECT OF LESSONS.

OCTOBER, 1904.

Alfalfa.
Chipmunk.
Silo.
Wild Flowers.
Canada Thistle and Other Seeds.

NOVEMBER, 1904.

Pumpkin.
Sumac.
Soils.
Note Books.
Collection of Seeds.
Paper White Narcissus.
Woodpecker.
Letters to Uncle John.

DECEMBER, 1904.

Horses.
Evergreens { White Pine. Pitch Pine. Norway Spruce. }
Christmas Trees.

JANUARY, 1905.

Dogs.
Leafless Trees.
Berries.
Geranium.
Diseased Apple.
School Grounds.

FEBRUARY, 1905.

Cows.
Garden.
Birds and Bird Houses.
Color in February.
Morning Talks.

MARCH, 1905.

Cats.
Willows.
Texture of the Soil.
Experiments with the Soil.

APRIL, 1905.

Poultry.
Protect Wild Flowers.

How We Can Help the Birds.
Experiments with the Soil.
How the White Pine Grows.
Letters from Junior Naturalists.

SUPPLEMENT.

Pictures for Junior Naturalists.
Something for Children to Plant.

MAY, 1905.

The Brook and the Brookside.
Formation of the Soil.
Blossom-time and Seed-time.
Story of a Boy, a Hen and Some other Things.

LETTERS BY SUBJECTS.

Alfalfa	1,021
Berries	114
Birds	1,587
Brook	399
Canada Thistle	392
Cats	2,998
Chipmunk	1,669
Christmas Tree	103
Cow	2,183
Dog	3,250
Garden	350
Grow under Trees	367
Horse	2,997
Moon	16
Naming Bird	11
Naming Tree	275
Note-books	102
Pine and Hemlock Trees	77
Plants	220
Poultry	1,520
Protect Wild Flowers	82
Pumpkin	3,383
School Grounds	232
Seeds	120
Seed Travelers	792
Silo	1,791
Soil	825
Squash	2,145
Sumac	1,162
Sunflower	502
Trees	297
Twigs	806
Vaccinate Apple	140
Woodpecker	1,112
Miscellaneous	814

Report of the Junior Naturalist Clubs for the Year 1904–1905.

The organization of Junior Naturalist Clubs is a movement for the purpose of introducing agricultural nature-study into the public schools of New York State. These clubs have been carried on under the auspices of the Cornell University College of Agriculture during the past seven years, and we have been able to see a steady increase in interest and efficiency in the work.

The method of carrying on the correspondence work with the children by means of Junior Naturalist Clubs is as follows:

Through the teachers of the schools we organize the children into correspondence clubs. These clubs are carried on in a formal or in an informal way, as best suits the teacher. From the university each member of the Junior Naturalist Club receives a monthly leaflet containing suggestive lessons along the line of agricultural nature-study. There are always four or five subjects suggested in each leaflet from which the children may choose one or more. The lessons are given in such a way that the young people are obliged to study the real thing and are not able to get their information from books. When they have prepared their lesson, they write to tell what they have done in their investigational work. Along this line we have had some very satisfactory results. Following are a few sample letters showing the type of the children's correspondence.

DEAR UNCLE JOHN:

I am going to write you about the vegetable contest which the fifth grade had. Some had onions, lettuce, cabbage and radish. They put it in a basket and brought them to school to see which were the largest and best. After they had decided which were the best they took them down to the superintendent's house, Mr. McLane, and he ate them for his supper. He said they did better than people who raise them to sell. I forgot to tell you I was a member of the Pioneer Junior Naturalist Club. I guess I have written all that I know.

Your loving niece,

ANNA.

DEAR UNCLE JOHN:

I thought I would write you a few lines. I studied about the apple. I took an apple and cut it in two. The apple had two seeds on one side and two on the other side. I took a rotten apple and cut it in two, and I could see where the worm had come out of the apple. The worm came out of the side of the apple.

We had a cricket at school, and we had a flower pot for its home and a lamp shade over the flower pot.

We had a little box with a glass in the side of the box. Every morning when I would come to school I would put some plantain leaves in the box. Some of the caterpillars made cocoons. We put the cocoons in a little box and put them in the closet.

I guess I will close for this time. I couldn't write very well. I wish for you to excuse me this time. I think I can write better the next time.

Your loving friend,
MYRTLE.

DEAR UNCLE JOHN:

We are delighted with our Junior Naturalist Club, and this month we have been noticing plants. We planted some hyacinths in our school room, and we first saw the bud peep out from near the roots about the 10th of February. It is a purple flower and has five bells on it; and we noticed that the lowest bell opened first and on up to the last one on top. Every day that it was pretty and bright we would set the box that had the flowers in it out in the sun, and we did not water them every day. We also sprouted the seeds of beans to see their jackets burst, and see the little leaves unfold.

Uncle John, can you tell us how the bee gets the honey out of the flower? Does he have a long tongue, or does he have a long under lip? Please tell us if you can.

Your nephew,
MILTON.

DEAR UNCLE JOHN:

I am going to ask you a question. We organized in December, and do we have to read September, October and November numbers? I have gotten a few of your questions in the January number.

1. One-fourth of the apple is taken up by the core.
2. There are eight compartments in the whole apple.
3. There are two seeds in each part.
4. The seeds point toward the stem.
5. The seeds are attached to the core, by the little end of the seed.
6. It is gathered right up in the blossom end.
7. I see the stem in the opposite end.

Your nephew,
S. C.

DEAR UNCLE JOHN:

I have something I would like to tell you. The other day the hired man was picking apples in the top of one of the trees. He found an old robin's nest and pieces of corncobs. I think it was a squirrel's work, because we have a walnut tree in our yard.

Tuesday morning papa was barreling apples. He told me to go up and get a barrel out of the corn crib. When I was getting it out, I looked in it and there was a big, black butterfly. I took it to the house till I went to school. When I went to school I took it along and the teacher said we would keep it in the school house and see how long it would live, for it would freeze to death out-of-doors.

For the next meeting we are going to study about different kinds of leaves. To-day the boys started out looking for something to bring before the next meeting.

I am sure we would all enjoy it for you to come and visit us.

Yours truly,

WALTER.

DEAR UNCLE JOHN:

About three weeks ago I found an insect on a leaf of corn; it was fastened on by a woolly string. When I found him, he was green with gold spots on him. We kept him awhile and he begun to have black streaks on him. We have had him about three weeks and it is beginning to crack his shell. There is a little green on him yet. His sides are red with black streaks on them. There are some white spots coming on him. The upper part where he is fastened to the corn has rings running about it. His shell is clear now. We can see his mouth and eyes.

Yours truly,

MORTON.

DEAR UNCLE JOHN:

We have a terrarium which was made out of an old umbrella rack. I had some screen around it. We have a broad-winged katydid, grasshoppers, and some angle worms, and a caterpillar that we call a woolly bear. There is a salamander in there, but he is down among the rocks and dirt. There are two frogs and some crickets. The frogs are asleep under dirt and stones. There is some moss in the terrarium. We planted some grass in one corner of the terrarium. There are some oats in the other corner of the terrarium that we planted.

The katydid was found on an apple core. The katydid is of a dark green color. The katydid has two pairs of wings and three pairs of feet.

Your friend,

ALFRED.

DEAR UNCLE JOHN:

We have had three meetings since we organized. We hold our meetings in the school house on Friday afternoons. At our second meeting we held a general discussion on "Birds." The result was the building of about 15 bird houses by members of the club.

A discussion of some of the articles in the September number of *Junior Naturalist Monthly* was held at the third meeting. We also had some observation work with a salamander that had been captured.

We have seen three bluejays robbing a robin's nest of three eggs. One of the bluejays kept the robin off while the other two robbed the nest, but she has laid one egg in the nest again.

From your nephews and nieces,

THE LONE HILL J. N. C.

OBSERVATIONS ON A PLANT.

Feb. 17. Planted an onion in a flower pot, a bean in an egg shell, also an orange seed. Had the soil moist.
Feb. 18. Did not water to-day; was moist enough.
Feb. 19. Watered to-day.
Feb. 20. Did not water to-day; did not need it.
Feb. 21. Watered to-day; no sign of them growing.
Feb. 22. Watered to-day.
Feb. 23. Did not water to-day.
Feb. 24. No sign of them growing.
Feb. 25. Watered to-day. Think the onion is growing and the orange seems to be coming up.
Feb. 26. Did not water to-day.
Feb. 27. It was only a weed, not the orange coming up.
Feb. 28. Watered to-day.
Mar. 1. The onion is growing.
Mar. 2. Watered to-day.
Mar. 3. Watered to-day.
Mar. 4. Onion up about half an inch.
Mar. 5. Watered to-day.
Mar. 6. Watered to-day.

Mar. 7. Onion up an inch.
Mar. 8. Watered to-day.
Mar. 9. Watered to-day.
Mar. 10. My onion does not take up all the room in the pot, so I have planted some beans on the edge.
Mar. 11. Watered to-day.
Mar. 12. Watered to-day.
Mar. 13. My bean does not come up yet. Watered again.

MARJORIE.

DEAR UNCLE JOHN:

I am going to tell you about the last time I went out into the country. I and three more boys went to a near-by woods, called Seepmores woods. We intended to get beechnuts, but when we got there the outer shells hung on the tree, but the inside was gone. I think the squirrels must have beaten us. So we went over the road for a walk, and came to an apple tree which stood near the road. We got quite a few apples here and then went further on. Soon we came to a tree bearing snow-white apples. Now all four had our coats and waists full, which amounted to nearly a bushel. Then we came back. On the way back we got into a swamp and had to go back. Then we saw a woodpecker sitting on a tree. One boy wanted to hit him with a stone, but I said no, see what he does. He pecked on a tree and then flew away. As he went so quick, I could not get a good look at him, so I could not describe him. We were gone from 8 A. M. until 2 P. M.

The other day we went after minnies because the Mohawk is flooded. We did not go far because it was cold and we got no minnies.

Yours with respect, FRED.

DEAR UNCLE JOHN:

We went up the hill on Thursday afternoon as far as John Brady's field, and while we were going over the road we stopped at his cabbage field to see if we could get any bugs off them. We got a whole lot of them. We put them in a pail. While we were picking one of us pulled a head of cabbage and began to throw it. John happened to be coming up a field. We all stood and showed him all the bugs. We went on a little further. We came to a field where there was a lot of rock and stones. We lifted them up, and we found a whole wasp's nest. I lifted a big stone, and we found a ground mole who lived in the stones.

Yours cordially,

WILLIE.

DEAR UNCLE JOHN:

I thought I would write to you. I have received your papers. I am very pleased with them. I get so interested in them that I cannot quit reading them when I start. I am very pleased in joining the club.

In studying about the sparrow, I find that he is about six inches long from bill to tail, and he is gray. Of course, there are many kinds of sparrows, but I mean the English sparrow. I see larger numbers of sparrows in the country, because there is more room for them to stay in the country. The female has not the black mark on throat or breast. The sparrow's eggs are gray. The sparrows eat wheat and oats. I know that, for I have seen them when I feed my chickens come and eat with them. The sparrows roost in barns and trees and many other places. From your loving friend,

BESSIE.

To all the members of the Junior Naturalist Clubs who have done satisfactory work, we have sent a small picture as illustrated below.

No. 1.—Cows at pasture.

No. 3.—Field of corn.

No. 2.—Belgian hares.

No. 4.—Hen with brood of ducklings.

No. 5.—Milkweed distributing its seeds.

No. 7.—Feeding the calf.

No. 6.—Off for the woods.

No. 8.—Turkey afield.

Miniature samples of pictures to be sent those Junior Naturalists who write four acceptable letters during the school year. The pictures themselves are $3\frac{3}{4}x6\frac{1}{4}$ in. in size, each printed separately on heavy paper, with wide margin. Choose the one you want by number.

These pictures are sent in recognition of a definite amount of work. Last year the request was that each child should prepare at least four monthly lessons, and the result was that 264 clubs met the requirements and received the pictures.

Our Junior Naturalist Clubs have been organized in all but four of the counties of New York State. Tompkins county takes the lead in interest, having 57 clubs; Chautauqua second with 32; Monroe third with 24. In other counties we have clubs numbering from one to 23.

JOHN W. SPENCER,
Supervisor Bureau of Nature-Study.

IX. HOME NATURE-STUDY FOR TEACHERS.

I have the pleasure of submitting to you the following report of the work done in the correspondence course of Home Nature-study during the past year.

During the fall of 1904 our leaflets were, with the permission of the State Department of Public Instruction, prepared especially for work in the training classes in the various public schools of the state. But owing to the fact that no list of these classes was furnished us until December, when the work for the year had been arranged and planned by the training-class teachers, we found it too late to do the work we hoped to do. In all we had 25 training classes, and these took the work because the teachers had been using our leaflets during previous years. Most of these classes kept up the work for the year in a most gratifying manner.

During the year we issued lessons for eight months in four leaflets. At first it was intended to send these leaflets only to those who answered the questions contained in them and sent the same to us. But the requests for the leaflets were so numerous from teachers who had no time to do the work, that we yielded to the pressure and sent out our lessons as follows:

October-November	1,918 copies
December-January	1,945 copies
February-March	1,968 copies
April-May	2,003 copies

As each of these leaflets covered several distinct topics our work aggregated the placing of 23,000 practical, simplified lessons in nature-study into the hands of the teachers of New York State. Of these, 2,000 were written out and returned to us, giving evidence of excellent work. In summing up last year's work, I find that we had fewer regular pupils sending in monthly answers than ever before, but, on the other hand, we had a greater demand for the leaflets than ever before.

At the beginning of the present school year an attempt was made to confine our work to the purely rural schools. One hundred and fifty letters were sent to the students who attended our short course last winter asking their help, and 600 letters were sent to the secretaries of the Granges of New York State asking their aid in interesting the teachers of the district schools in this work. In consequence of these efforts, we have had requests for the work from 500 teachers in country schools from all parts of the state.

In order to make the work of real use to the farmers, the economic phases of nature-study have been emphasized. We have offered the following topics for study, all of them dealing directly with agriculture and the needs of the farm.

BIRD STUDY.

Learning the names of common birds, their food habits, and their value to the farmer and orchardist.

A study of the birds that winter here and their good work in the forest and orchard.

Where and how our common birds spend the winter; the reason for the migration of birds.

A spring calendar of common birds, which shall include the story of their nest-building and food of nestlings.

The game laws of New York State as applied to birds.

A knowledge of the Government publications on the relation of birds to agriculture.

Suggestions for using bird study as a help in language work and geography.

PLANT STUDY.

A knowledge of the wild flowers that blossom near the school house in September and October, including their names and their uses.

The making of an interesting herbarium of all the plants in the neighborhood of the school.

The methods of seed distribution of 10 common weeds.

A study of the common woodland flowers in spring, such as the hepatica, adder's-tongue, Jack-in-the-pulpit, trillium, etc.

The making of a wild-flower garden.

TREE STUDY.

Learning all the trees by name that grow within a mile of the school house; a study of their fruits, leaves, bark, flowers and seeds.

The common uses of the wood of the different species of trees.

The relation of the trees to the soil and the water supply.

The making of a tree herbarium.

The value of forestry on the farm.

Suggestions for using tree study as an aid in the teaching of geography, history, language and drawing.

INSECTS.

Learning common insects by name.

The study of the life habits of any insects which are troubling the farms or orchards in your locality, and teaching the children, if possible, how to destroy them.

A study of the life habits of the large moths, cecropia, luna, etc.

A study of some of our common butterflies.

Making an insect collection for the school.

Suggestions for the relation of insect work with language, drawing, etc.

FISH STUDY.

The names of the common fishes of the streams; what happens to them the year through; their food and their nesting habits.

How to preserve desirable fish in our streams.

The study of a fish, how its form, color, eyes, mouth, fins and gills fit it for its life in the water.

The game laws of New York State as applied to fish.

Suggestions for the use of the study of fish as an aid to the study of geography.

Of the 500 teachers who have applied for the work above outlined,

322 have applied for the bird work,
282 for the tree study,
290 for the plant study,
241 for insect study,
181 for fish study.

Aside from the leaflets, special letters have been sent to each of the applicants giving them general suggestions for the special work which they have chosen.

ANNA BOTSFORD COMSTOCK,
Lecturer in Nature-Study.

X. THE FARMERS' WIVES' READING COURSE, 1904–1905.

The third year of the Farmers' Wives' Reading-Course of Cornell University is completed with a membership of 17,800 women in the state. This number indicates a live membership, since the membership has within the year been revised, and the bulletins sent only to those who replied that the post-office address was correct, and that they desired a continuation of the reading.

The course is free to women in the state who indicate that they desire a course of reading and study upon the subjects pertaining to the home work; not simply the routine of housework, but the allied subjects of society and school.

The Reading-Course for Farmers' Wives is a parallel one to that of the farmers, based upon the same general plan, consisting of illustrated bulletins published five months of the year. Accompanying the bulletin is a discussion paper containing questions which are to be answered and returned to the bureau.

In the Farmers' Wives' Reading-Course there are now three series of five bulletins each:

Series I. *Farm House and Garden.*—The bulletins in this series are: (1) Saving Steps; (2) Decoration in the Farm Home; (3) Practical Housekeeping; (4) The Kitchen-Garden; (5) The Flower-Garden.

Series II. *The Farm Family.*—The bulletins in this series are: (6) Rural Schools; (7) Boys and Girls on the Farm; (8) Reading in the Farm Home; (9) Home Industries; (10) Insect Pests of House and Garden.

Series III. *Food and Sanitation.*—The bulletins in this series are: (11) Home Sanitation; (12) Germ Life; (13) Human Nutrition; (14) Food for the Farmer's Family; (15) Saving Strength.

While the sending of bulletins and the examination of discussion papers forms a prominent feature of the work of the reading-course, the answering of questions written by the readers to the department in all phases of home life is an important element which makes the movement more individually helpful than anything else. It is more than ever recognized that the farm where so many home occupations are carried on must necessarily, in order to be successful, be based upon a scientific knowledge concerning sanitation and food on the farm. The farm is a most desirable place in which to practice the art of home-making.

The object of the course is to make the farm home an ideal one, to make those who dwell in rural communities contented in their environment, and desirous to make the most of natural surroundings.

MARTHA VAN RENSSELAER,
Supervisor Farmers' Wives' Reading-Course.

XI. FARMERS' READING-COURSE.

The Farmers' Reading-Course has proceeded along the lines that were determined a year ago. A full report of the Farmers' Reading-Course work, stating the methods and points of view, was made by Professor Fletcher in the report for the year ending September 30, 1904. In September, 1905, Professor Fletcher severed his connection with our work to become professor of horticulture in the Michigan Agricultural College and his work for the present year, so far as the Farmers' Reading-Course is concerned, is to be conducted by Mr. George W. Hosford.

Following are the statistics of the Farmers' Reading-Course for the past year. In some cases the same person is reading in more than one series:

SUMMARY OF THE YEAR'S WORK IN FARMERS' READING-COURSE FROM OCT. 1, 1904, TO OCT. 1, 1905.

New Readers.

Series I, Soil	2,807
Series II, Stock	3,548
Series III, Orcharding	1,262
Series IV, Poultry	1,483
Series V, Dairying	454
	9,554

Discussion Papers.

Series I, Soil	1,143
Series II, Stock	761
Series III, Orcharding	240
Series IV, Poultry	710
Series V, Dairying	160
	3,014

Clubs.

Reorganized clubs	63
New clubs	62
	125
Number of readers in clubs	2,546

L. H. BAILEY.

REPORT OF THE TREASURER.

STATEMENT OF RECEIPTS AND EXPENDITURES OF CORNELL UNIVERSITY AGRICULTURAL EXPERIMENT STATION FOR THE FISCAL YEAR ENDING JUNE 30, 1905.

Receipts from the Treasurer of the United States as per appropriation for fiscal year ending June 30, 1905, as per Act of Congress, approved March 2, 1887..		$13,500 00
Expenditures.		
Salaries	$9,916 41	
Labor	956 25	
Publications	786 61	
Postage and stationery	183 04	
Freight and express	49 93	
Heat, light, water and power	20 04	
Chemical supplies	129 87	
Seeds, plants and sundry supplies	178 62	
Library	99 31	
Tools, implements and machinery	1 25	
Furniture and fixtures	209 45	
Scientific apparatus	65 57	
Traveling expenses	193 92	
Contingent expenses	100 21	
Buildings and repairs	609 52	
		$13,500 00

We, the undersigned, duly appointed auditors of the corporation, do hereby certify that we have examined the books and accounts of the Cornell University Agricultural Experiment Station for the fiscal year ending June 30, 1905; that we have found the same well kept and classified as above, and that the receipts for the year from the Treasurer of the United States are shown to have been $13,500, and the corresponding disbursements $13,500; for all of which proper vouchers are on file and have been by us examined and found correct, thus leaving no balance.

And we further certify that the expenditures have been solely for the purposes set forth in the Act of Congress approved March 2, 1887.

(Signed) R. B. WILLIAMS,
(Seal) MYNDERSE VAN CLEEF,
Auditors.

Attest: EMMONS L. WILLIAMS,
Custodian.

STATEMENT OF THE SCHEME OF EXPENDITURES UNDER THE STATE APPROPRIATION FOR THE EXTENSION OF AGRICULTURAL KNOWLEDGE FOR THE YEAR ENDING SEPTEMBER 30, 1905.

Salaries	$19,480
Office, printing and special investigations	5,000
Stenographers	1,000
Nature-study	2,800
Home nature-study	1,200
Reading-courses	3,300
Entomology	500
Animal husbandry	600
Agriculture and chemistry	1,000
Botany	300
Horticulture	800
Dairy industry and school	3,000
Poultry	1,020
	$40,000

September, 1904 BULLETIN 222

CORNELL UNIVERSITY

AGRICULTURAL EXPERIMENT STATION OF THE COLLEGE OF AGRICULTURE

Animal Husbandry Department

RECORD OF AN ATTEMPT

To Increase the Fat in Milk

BY MEANS OF

LIBERAL FEEDING.

By HENRY H. WING and JAMES A. FOORD.

ITHACA, N. Y.
PUBLISHED BY THE UNIVERSITY.

ORGANIZATION

Of the Cornell University Agricultural Experiment Station.

EXPERIMENTING STAFF.

LIBERTY H. BAILEY, Director.
JOHN HENRY COMSTOCK, Entomology.
HENRY H. WING, Animal Husbandry.
GEORGE F. ATKINSON, Botany.
JOHN CRAIG, Horticulture.
THOMAS F. HUNT, Agronomy.
RAYMOND A. PEARSON, Dairy Industry.
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MARK V. SLINGERLAND, Entomology.
GEORGE W. CAVANAUGH, Chemistry.
JOHN L. STONE, Agronomy.
JAMES E. RICE, Poultry Husbandry.
STEVENSON W. FLETCHER, Horticulture.
JOHN W. GILMORE, Agronomy.
ROBERT S. NORTHROP, Horticulture.
HERBERT H. WHETZEL, Plant Pathology.
SAMUEL FRASER, Agronomy.
JAMES A. BIZZELL, Chemistry.
JOHN M. TRUEMAN, Animal Husbandry and Dairy Industry.
CHARLES E. HUNN, Horticulture.

Office of the Director, 17 Morrill Hill.

The regular bulletins of the Station are sent free to persons residing in New York State who request them.

RECORD OF AN ATTEMPT TO INCREASE THE FAT IN MILK BY MEANS OF LIBERAL FEEDING.

Of all the problems that have been under discussion concerning the production, nature and composition of milk, probably none has been the subject of more controversy than the question of how far the composition of the milk, especially its fat content, is influenced by the food of the cow. One reason for this discussion is that the results of investigation soon ran contrary to the generally received opinion of farmers and dairymen. For a long time the opinion has been very strong in the minds of dairymen that the percentage of fat in milk is directly and largely influenced by the food of the cow. If 99 out of 100 dairymen are asked whether they can make their cows give richer milk by changing the food, they will answer at once in the affirmative, and many will go so far as to say that they have done it time and again. Still this is one of the results that careful investigators have been trying to secure for the last 20 years and so far they have met with little or no success.

In a recent bulletin* summing up the work done along this line at various institutions in this country and abroad, the conclusion was reached, that in general terms, it is not possible materially and permanently to increase or diminish the percentage of fat in the milk of a cow through changes in the amount or character of the food. Following the publication of this statement, came several criticisms, the most noticeable of which was to the effect that the cows experimented with were not calculated to show a difference in the percentage of fat, because the animals under trial were cows that had been kept always on an abundance of good food, and had never lacked for food in any way. They had already been developed to their highest capacity and it is not to be expected that such cows will show a very marked change in the fat content of the milk following a change in the food. If, on the other hand, cows had been taken as they are ordinarily found in the country, the larger number of which are insufficiently fed and have never had a chance to develop, it would be possible to materially increase the percentage of fat in the milk by giving the cows an abundance of rich food. It seemed to us that perhaps the criticism was well taken, and that there might be many

* Cornell University Agricultural Experiment Station Bulletin No. 173, November, 1899, "The Relation of Food to Milk Fat."

herds of poor cows which it would be possible to develop so that they would give milk containing a higher percentage of fat.

1. General Plan and Purpose of the Experiment.

The experiments detailed in the following pages give the results of an attempt to increase the percentage of fat in milk of a herd of cows previously kept under adverse conditions. The experiments were begun in March, 1900, and were continued four years.*

In planning the experiment it seemed desirable to secure a herd that should fulfill as nearly as possible the following conditions:

(a) It should be of at least considerable size.

(b) It should have been established on the same farm for some time.

(c) A large proportion of the animals should be comparatively young.

(d) All the cows should drop their calves as nearly as possible at the same time.

(e) The herd should have a reputation of having been insufficiently fed for several years.

After some inquiry and investigation a herd was found within easy driving distance of the University that answered all of the above conditions very fully. There were 21 cows in the herd. Of these only four were more than 8 years old, all but one had calved within two months of one another and all were very thin in flesh. They were of native and mixed breeding. A few evidently were low-grade Jerseys. Several showed traces of old-fashioned milking Short Horn blood. A considerable number of the cows had been raised by the owner and most of the others had been bought when quite young. The owner, Mr. G. W. Gibson, was willing to undertake the work asked of him and he has readily co-operated with the Station during the whole course of the experiment, and to him the thanks of the Station are due.

A record of the production of the herd in milk and fat was then kept for one entire lactation period on the farm of the owner without

* Credit for the necessary preliminary investigations, the inauguration of the experiment and for the details of the work for the first three months is due to Mr. Leroy Anderson, now director of the California Polytechnic Institute, San Luis Obispo, California. From July, 1900, to October, 1903, the experiment was under the direct charge of Mr. James A. Foord, now professor of agriculture in Delaware College, Newark, Delaware. Mr. Foord has also made most of the calculations, prepared the tables and helped in writing the bulletin. From October, 1903, till the close of the experiment, the records were kept and the necessary details carried out by Mr. John M. Trueman who, since Mr. Foord's resignation, has been assistant in animal husbandry and dairy industry.

in any way changing the conditions under which the animals had lived. At the close of this lactation period, 10 cows from the herd were purchased and brought to the University, where they were fed liberally for two years, records of production being constantly kept as before. At the end of the two years, seven cows (three had been disposed of) were returned to the farm from which they were purchased and kept under conditions practically identical with those of the first year, and records kept as before. That is, the experiment is divided into three parts: (1) on a private farm, one lactation period; (2) at the university, two lactation periods; (3) on the private farm again, one lactation period.

In making the records, the milk was weighed and recorded at each milking and a part taken for a composite sample. The composite samples were preserved for one week and then tested. This course was followed during the whole time of the experiment, both when the cows were at Mr. Gibson's and when they were at the university.

While the cows were at Mr. Gibson's, he undertook the daily weighing and sampling of the milk. Once each week, an officer of the Station (usually the one in direct charge of the experiment) drove to Mr. Gibson's, secured the records and samples for the preceding week and left fresh bottles for samples to be taken the following week. The samples so secured were brought to the university and the fat determined by the Babcock Centrifugal method.

While the cows were at the university, they were kept with the regular university herd. The weighing and sampling was done by the regular milkers and the fat determined as before. All the food for each animal was weighed separately during the time the cows were at the university. While at Mr. Gibson's no attempt was made to keep a record of the food by weight; but a careful estimate of the grain and hay consumed was made. By far the larger part of the food during the time that the records were kept at Mr. Gibson's was pasturage.

The following table shows the product of each cow for the time she was in milk from March 28, 1900, when the experiment began, till November 7, 1900, for the cows that were left at Mr. Gibson's, and till the close of lactation for the ten cows that were removed to the university. The names of these 10 cows are in bold-faced type:

TABLE I.—PRODUCTS OF THE TWENTY COWS IN THE FIRST PERIOD.

NAME.	Age.	Number of weeks in milk.	Pounds milk.	Pounds fat.	Average per cent fat.
Clover	17	34	2,854	123	4.31
Platt	16	32	2,829	103	3.64
Brown	15	25	2,725	98	3.60
Douglas	....	22	2,122	78	3.68
Chloe	8	34	3,052	130	4.26
Rena	6	34	4,218	155	3.66
Stella	6	29	2,476	129	5.22
Tilda	6	19	1,965	73	3.71
Rita	5	39	4,435	174	3.92
Brindle	4	32	3,889	156	4.01
Spike Horn	4	32	3,674	141	3.84
Light Red	4	32	2,734	142	5.23
Dena	4	39	3,243	156	4.82
Bald Face	4	31	3,002	108	3.60
Black Head	4	31	3,262	153	4.69
Square Face	4	31	3,902	157	4.02
Patty	4	38	4,030	172	4.27
Polly	4	37	3,143	177	5.64
Dinah	2	45	4,001	169	4.22
Pansy	2	29	2,640	112	4.24
Daisy	2	27	2,609	106	4.06

The ten cows that were purchased and removed to the university were selected in such a manner as to divide the whole herd in two parts that should be as nearly alike as possible in age, breeding, productive capacity and general characteristics. Reference to the above table will show how far we were successful in accomplishing this, since the names of the cows that were purchased are printed in heavy type.

At the time the cows were brought to the university, they were dry or very nearly so, and, as has already been said, were very thin in flesh. During the first winter they were fed with the object of making them take on some flesh, so that they should come into milk in better condition than the year before. All dropped their calves before the middle of April, 1901. A comparison of the weight on November 8, 1900, and on May 1, 1901, will therefore give an idea of the increase during the winter, and is shown in the table below:

TABLE II.—WEIGHTS OF THE COWS AT THE CLOSE OF THE FIRST PERIOD AND THE BEGINNING OF THE SECOND PERIOD.

NAME OF COW.	Weight Nov. 8.	Weight May 1.
	Pounds.	*Pounds.*
Chloe	1,065	1,045
Clover	791	810
Dena	701	735
Dinah	640	755
Patty	817	925
Polly	698	840
Rena	877	930
Rita	791	885
Stella	924	970
Tilda	987	845
Total	8,291	8,740
Average gain	....	45

It should be said in regard to the cow Tilda that she was heavy in calf on November 8. She dropped a calf on November 29 and was milked all winter. This accounts for the apparent loss in weight. As a matter of fact, to the eye she was in better condition on May 1 than on November 8.

With the exception of Tilda mentioned above and Chloe, who dropped a calf on January 12, the cows dropped calves between March 3 and April 11, 1901. It was during this lactation period, the second of the experiment and the first at the university, that the main object of the experiment was sought to be accomplished: namely, to increase the percentage of fat in the milk by means of abundant food. To this end the cows were fed with the single idea of giving them all they would readily eat of nutritious easily digestible food, containing an abundance of protein. Economy of production was not sought nor even borne in mind. While in the stable the coarse fodder was mixed clover and timothy hay and silage. During the summer the pasture was as abundant as was possible to provide and was supplemented with soiling crops whenever necessary. The concentrated part of the ration was that used for the general university herd and was varied somewhat in amount from time to time. As nearly as possible it was all that the animal would eat regularly without going "off feed." It was continued with pasture and till the milk flow became very small near the close of the lactation period.

During the third lactation period the cows were given similar foods, but they were fed with the idea of economy of production, that is, to furnish all the coarse fodder the animal would eat readily and as much concentrated food in addition as returns would be made for at the pail.

In the fourth year the cows remaining were returned to Mr. Gibson and were treated practically the same as during the first period.

A better idea of the system of feeding may be gained from a comparative statement for the four lactation periods, as follows:

FOOD FOR THE FOUR LACTATION PERIODS.

First Period, 1900.

Cows on the Farm of Mr. Gibson.

The records were begun March 28, 1900. From this time until the cows were turned to pasture, they received a moderate ration of timothy hay with a very little clover in it, and about four pounds a day of a mixture of gluten feed and wheat bran or middlings. On May 16th the cows were turned on pasture. The pasture was low and for the most part contained only natural grasses, and as the season was a dry one was very scanty after July 1. The grain ration was continued while the cows were at pasture until September 1st. From this time, they received beside the very scant pasture only what apple pomace they would eat.

The ration, while hay was fed, furnished about 1.3 pounds of digestible protein per cow per day with a nutritive ratio of 1.8.

Second Period, 1901.

Cows at the University.

The cows were brought to the university early in November, 1900. They were then dry or very nearly so and very thin in flesh. During the winter they were fed silage and hay ad libitum and a moderate grain ration (about six pounds daily). As soon as they freshened, which was in most cases in March and April, the grain ration was increased till each cow was getting all she would readily consume, and this was continued during the whole season both in the stable and on pasture till the flow of milk diminished at the close of the lactation period. The amount given was in most cases 12 pounds per day, though one cow ate 14 pounds per day for three months. The feeds were largely cottonseed meal, wheat bran, gluten feed, buckwheat middlings and old process linseed oil meal. While the cows were dry in the winter of 1900–1901, some ground oats and corn meal were used.

From April 1st to June 11th, 12 pounds per day of a mixture of equal parts of cottonseed meal, linseed oil meal, corn meal and wheat bran was fed.

From September 4th to October 8th, eight pounds of bran alone was fed. The proportions of the different foods were varied somewhat from time to time, according to convenience. In no case did the nutritive ratio of the whole ration exceed 1:5.5 and much of the time it was considerably narrower. In several cases the cows consumed more than three pounds per day of digestible protein for considerable periods of time.

Third Period, 1902.

Cows at the University.

While the cows were dry between the second and third periods, they were given hay and silage ad libitum but no grain.

In the third lactation period they were fed much as they were in the second period as to kind and combinations of food, the chief change being that in the latter part of this period malt sprouts formed a considerable part of the grain ration.

The amount of grain was materially reduced, however, the idea being to feed no more than the individual cow could make returns for at the pail. Eight pounds per day was the maximum, except for one cow that was given 10 pounds per day for a little over one month.

The nutritive ratios of the various rations varied very little from those of 1901, but because of the smaller ration the consumption of protein as well as the other constituents was considerably reduced.

Fourth Period, 1903.

Cows on the Farm of Mr. Gibson.

The cows were fed practically the same as in 1900. The pasture, however, was very much better because of abundant rains. For this reason no grain was fed after July 1st and but very little in June.

II. Description and Records of the Cows Brought to the University.

1. Chloe.

This was a native cow of good form and good size. She was said to be eight years old and would have been selected by a stranger as one of the best in the herd. She had lost both forequarters of the udder and gave milk only from the two hind teats. At the beginning of the experiment she had been in milk for eight weeks. At the university she proved to be a poor feeder. For this reason and because of her imperfect udder she was dried off and sold in September, 1901. Her lactation periods were as follows:

1900	March 28 to Nov. 20	34 weeks
1901 Dropped calf	Jan. 12, dry Sept. 7	33 weeks

	Weeks in milk.	Pounds of milk.	Pounds of fat.	Average per cent of fat.	Gain or loss in per cent of fat over preceding year.
1900	34	3,052	130	4.26	—.28
1901	33	3,722	148	3.98	....

2. Clover.

Clover was a grade Jersey cow of good form and fair size. She was the oldest cow in the herd, and when the cows were brought to the university she was so thin in flesh that it was doubtful whether she would survive the winter. She did survive, however, and produced a calf, but she gained very little in flesh and no attempt was made to breed her again. (Figs. 1 and 2, p. 20, 21.) When the experiment began she had been in milk about four weeks.

Her lactation periods were as follows:

1900	March 28 to Nov. 20	34 weeks
1901 Dropped calf	March 3, dry Feb. 1, 1902	47 weeks

	Weeks in milk.	Pounds of milk.	Pounds of fat.	Average per cent of fat.	Gain or loss in per cent of fat over preceding year.
1900	34	2,854	123	4.31	....
1901	47	5,716	274	4.80	.49

3. Dena.

She was a small black cow of inferior shape, with perhaps a trace of Jersey blood. She had a poorly shaped udder and badly placed teats. However, she proved to be an excellent producer. She was suckling a calf when the experiment began and had been fresh for about a month. Her lactation periods were as follows:

1900	April 4 to Jan. 1, 1901	39 weeks
1901 Dropped calf	March 20, dry April 8, 1902	55 weeks
1902 Dropped calf	July 8, dry October 13, 1903	66 weeks
1903 Dropped calf	Dec. 28 to close of expt. Feb. 23, 1904	8 weeks

It will be seen that this cow ran farrow in 1902. Therefore her records for the third and fourth periods are not coincident with a lactation period. The record for the third period is from July 8, 1902, to February 23, 1903, or 33 weeks, at which time the cows were returned to Mr. Gibson's. The record for the fourth period is from February 23 to October 13, 1903, and from December 28, 1903, to February 23, 1904, or 41 weeks in all.

	Weeks in milk.	Pounds of milk.	Pounds of fat.	Average per cent of fat.	Gain or loss in per cent of fat over preceding year.
1900	39	3,243	156	4.82	....
1901	55	6,588	355	5.39	.57
1902	33	4,644	236	5.08	--.31
1903	41	3,602	180	5.00	—.08

4. DINAH.

This cow was a native two-year-old heifer. She was small and thin, but grew rapidly during the winter of 1900–1901. At calving in 1901 she had a severe attack of garget and lost half her udder. For this reason she was not bred again and was sold for beef in September, 1901. She did not enter the experiment until the second week and was then fresh in milk. Her lactation periods were as follows:

1900	April 4 to Feb. 15, 1901	45 weeks
1901 Dropped calf	April 11, dry Sept. 7	21 weeks

	Weeks in milk.	Pounds of milk.	Pounds of fat.	Average per cent of fat.	Gain or loss in per cent of fat over preceding year.
1900	45	4,001	169	4.22	....
1901	21	2,561	108	4.24	.02

5. PATTY.

This cow was nearly white in color and evidently was in some degree descended from Short Horn ancestry. At the beginning of the experiment she was small and decidedly inferior in appearance, but she grew rapidly and made a good-sized cow. She was one of the best in point of production. When the experiment began she was suckling a calf. She entered the experiment in the second week and had been in milk for about six weeks. (Figs. 3, 4, 5, p. 22, 23.) Her lactation periods were as follows:

1900	April 4 to Dec. 20	38 weeks
1901 Dropped calf	March 15, dry Jan. 15, 1902	44 weeks
1902 Dropped calf	April 21, dry April 7, 1903	50 weeks
1903 Dropped calf	June 18 to close of expt. Feb. 23, 1904	35 weeks

	Weeks in milk.	Pounds of milk.	Pounds of fat.	Average per cent of fat.	Gain or loss in per cent of fat over preceding year.
1900	38	4,030	172	4.27	....
1901	44	7,137	342	4.79	.52
1902	50	7,756	352	4.54	—.25
1903	35	4,568	194	4.25	—.29

6. POLLY.

This cow was very evidently a grade Jersey. She was of fair size and good form, but very nervous and easily excited. She gave the richest milk of any in the lot, and, like Patty, was one of the best producers, although she had lost one teat through accident.

She entered the experiment the third week and was then fresh in milk. Her lactation periods were as follows:

1900	from April 11 to Dec. 20.	37 weeks
1901 Dropped calf	March 23, dry Feb. 15, 1902	46 weeks
1902 Dropped calf	June 19, dry July 16, 1903	56 weeks
1903 Dropped calf	Sept. 22 to end of expt. Feb. 23, 1904	20 weeks

Like Dena, this cow ran farrow in 1902 and her records for the third and fourth periods have been divided in the same way. That is, the third period extends from June 19, 1902, to February 23, 1903, or 36 weeks, and the fourth period from February 23, 1903, to February 23, 1904, or excluding the time she was dry 40 weeks in all.

	Weeks in milk.	Pounds of milk.	Pounds of fat.	Average per cent of fat.	Gain or loss in per cent of fat over preceding year.
1900	37	3,143	177	5.64	....
1901	46	5,526	346	6.26	.62
1902	36	4,802	283	5.89	—.37
1903	40	2,945	184	6.25	.36

7. RENA.

Rena was a light roan cow of good size and form, evidently having some Short Horn blood. She had torn one teat badly on a barbed wire and gave no milk from that quarter except for a short time after coming in. She was suckling a calf at the beginning of the experiment and her records did not begin until May 2d, at which time she had been in milk about two months. Her lactation periods were as follows:

1900	from May 2 to Dec. 24	34 weeks
1901 Dropped calf	March 26, dry March 1, 1902	48 weeks
1902 Dropped calf	June 12, dry Feb. 15, 1903	36 weeks
1903 Dropped calf	April 22 to close of expt. Feb. 23, 1904	33 weeks

	Weeks in milk.	Pounds of milk.	Pounds of fat.	Average per cent of fat.	Gain or loss in per cent of fat over preceding year.
1900	34	4,218	155	3.66	....
1901	48	8,416	320	3.82	.16
1902	36	6,582	243	3.69	—.13
1903	33	5,230	180	3.44	—.25

8. RITA.

She was a native cow of medium size, red in color and of no marked characteristics. At the beginning of the experiment she was suckling a calf which was not sold till May 16th, at which time her records began. She had then been in milk about two months. (Figs. 9, 10, 11, p. 34, 35.) Her lactation periods were as follows:

1900	from May 16 to Feb. 15, 1901	39 weeks
1901 Dropped calf	March 19, dry March 1, 1902	49 weeks
1902 Dropped calf;	April 7, dry Feb. 1, 1903	44 weeks
1903 Dropped calf	March 13 to close of expt. Feb. 23, 1904	48 weeks

	Weeks in milk.	Pounds of milk.	Pounds of fat.	Average per cent of fat.	Gain or loss in per cent of fat over preceding year.
1900	39	4,435	174	3.92	....
1901	49	7,346	319	4.34	.42
1902	44	7,832	325	4.15	—.19
1903	48	5,468	213	3.90	—.25

9. STELLA.

This cow was large, squarely built, evidently of Short Horn descent, though she was naturally polled and was said to have some Red Polled blood. She was dark roan almost red in color, and had a tendency to take on flesh rapidly under good feed. She had been suckling calves for about 10 weeks when her records began on May 16th. Her lactation periods were as follows:

1900	from May 16 to Dec. 7	29 weeks
1901 Dropped calf	March 26, dry Dec. 15	38 weeks
1902 Dropped calf	May 3, dry Jan. 1. 1903	34 weeks
1903 Dropped calf	March 15, dry Nov. 10	34 weeks

	Weeks in milk.	Pounds of milk.	Pounds of fat.	Average per cent of fat.	Gain or loss in per cent of fat over preceding year.
1900.................	29	2,476	129	5.22	....
1901.................	38	5,203	276	5.31	.09
1902.................	34	4,207	206	4.90	—.41
1903.................	34	3,886	186	4.79	—.11

10. TILDA.

The cow Tilda was medium sized, showing some Short Horn blood. She was an excellent milker and had comparatively little tendency to take on flesh, though she was the heaviest feeder of any. At the beginning of the experiment she had been suckling calves for some time, at least for three months and probably longer. She was bred to calve again in December, 1900, so that her record for the first period includes only the latter half of a lactation period. She was milked more in the winter than any of the other cows, as the record of her lactation periods will show:

1900	from May 16 to Sept. 25	19 weeks
1901 Dropped calf	Nov. 29, 1900, dry Nov. 1, 1901	48 weeks
1902 Dropped calf	Feb. 12, dry Oct. 25	36 weeks
1903 Dropped calf	Jan. 10, dry Oct. 10	36 weeks
1904 Dropped calf	Dec. 4, 1903, to close of expt. Feb. 23, 1904	11 weeks

When the cows were returned to Mr. Gibson on February 23, 1903, this cow had been milked for six weeks in the fourth lactation. She calved again December 4, 1903, and was in milk at the close of the experiment. In making up her record for the fourth period we have included the product from February 23, 1903, to February 23, 1904, or 44 weeks, excluding the time she was dry, since this represents the product while she was under Mr. Gibson's treatment even though it is not all included in one lactation period.

	Weeks in milk.	Pounds of milk.	Pounds of fat.	Average per cent of fat.	Gain or loss in per cent of fat over preceding year.
1900	19	1,965	73	3.71	....
1901	48	8,978	337	3.76	.05
1902	36	7,686	293	3.81	.05
1903	44	5,744	196	3.41	—.40

Summary of Records of the Ten Cows.

For convenience we have brought together all the records of each animal in a single table:

TABLE III.—RECORDS OF THE TEN PURCHASED COWS.

YEAR.		Number of weeks in lactation.	Total pounds ol milk.	Total pounds of fat.	Average per cent of fat.	Gain or loss in per cent of fat each year.
Chloe	1900	34	3,052	130	4.26	....
	1901	33	3,722	148	3.98	—.28
Clover	1900	34	2,854	123	4.31	....
	1901	47	5,716	274	4.80	.49
Dena	1900	39	3,243	156	4.82	....
	1901	55	6,588	355	5.39	.57
	1902	*33	4,644	236	5.08	—.31
	1903	*41	3,602	180	5.00	—.08
Dinah	1900	45	4,001	169	4.22	....
	1901	21	2,561	108	4.24	.02
Patty	1900	38	4,030	172	4.27	....
	1901	44	7,137	342	4.79	.52
	1902	50	7,756	352	4.54	—.25
	1903	35	4,568	194	4.25	—.29
Polly	1900	37	3,143	177	5.64	....
	1901	46	5,526	346	6.26	.62
	1902	*36	4,802	283	5.89	—.37
	1903	*40	2,945	184	6.25	.36
Rena	1900	34	4,218	155	3.66	....
	1901	48	8,416	320	3.82	.16
	1902	36	6,582	243	3.69	—.13
	1903	33	5,230	180	3.44	—.25
Rita	1900	39	4,435	174	3.92	....
	1901	49	7,346	319	4.34	.42
	1902	44	7,832	325	4.15	—.19
	1903	48	5,468	213	3.90	—.25
Stella	1900	29	2,476	129	5.22	....
	1901	38	5,203	276	5.31	.09
	1902	34	4,207	206	4.90	—.41
	1903	34	3,886	186	4.79	—.11
Tilda	1900	19	1,965	73	3.71	....
	1901	48	8,978	337	3.76	.05
	1902	36	7,686	293	3.81	.05
	1903	*44	5,744	196	3.41	—.40

* See individual record, pages 28, 30 and 32

From the above table it will be seen that there were considerable variations in the percentage of fat in the various periods. In order to determine the effect upon the percentage of fat of the more liberal feeding while the cows were at the university, the percentage of fat in the milk of each cow for the first and fourth periods (scant ration) has been averaged and compared with the average of the second and third periods (liberal ration). The results are given in Table IV. Only the records of the seven cows that remained in the experiment for the entire time are used in this tabulation.

Table IV shows that, on the whole, the milk was one-quarter of one per cent richer in fat during the whole time the cows were on a liberal ration. The percentage of fat was therefore increased about 6 per cent. Further, each cow without exception gave richer milk while on the liberal ration. It would seem therefore that in the case of these seven cows the percentage of fat was "materially and permanently increased" by the influence of more and better food and that our thesis is answered in the affirmative, so far as it can be answered in an experiment using only a small number of individuals.

TABLE IV.—PERCENTAGE OF BUTTER FAT IN THE MILK OF THE SEVEN COWS AT THE UNIVERSITY.

NAME OF COW.	Average per cent of fat in milk, 1st and 4th periods (at Gibson's).	Average per cent of fat in milk, 2d and 3d periods (at University).	Gain While Under Liberal Feed.	
			Actual.	Per cent.
Dena	4.91	5.24	.33	6.7
Patty	4.26	4.67	.41	9.6
Polly	5.95	6.08	.13	2.2
Rena	3.55	3.76	.21	5.9
Rita	3.91	4.25	.34	8.7
Stella	5.01	5.11	.10	2.0
Tilda	3.56	3.79	.23	6.5
Average gain	....	....	.25	5.9

There are, moreover, several features of interest in Table III that will repay further study.

In general it will be seen that the increase in fat was much the most marked in the second period. In the third period there was a marked reduction and in the fourth period most of the cows gave poorer milk than in the first.

Comparing the first and second periods, a marked individuality of the various cows is seen. This is well shown in Table V, in which the cows have been arranged in order of the greatest increase in percentage of fat in the second period.

It will be seen that while the second gain of the whole 10 cows in the second period was almost exactly the same as the gain when the first and fourth periods were compared with the second and third, practically all of this gain was secured from five of the cows.

The first five cows in the table below gave milk richer in fat by more than one-half of one per cent in 1901 than in 1900, whereas the remaining five gave milk of very nearly the same fat content in both years.

Table V.—Gain of the Individual Cows.

NAME OF COW.	Average per cent fat 1st period, 1900, scanty ration.	Average per cent fat 2d period, 1901, liberal ration.	Gain in 2d period over 1st.
Polly	5.64	6.26	.62
Dena	4.82	5.39	.57
Patty	4.27	4.79	.52
Clover	4 31	4.80	.49
Rita	3.92	4.34	.42
Rena	3.66	3.82	.16
Stella	5.22	5.31	.09
Tilda	3.71	3.76	.05
Dinah	4.22	4.24	.02
Chloe	4.26	3.98	—.28
Average of all	....	....	.27
Average five showing greatest gain	....	....	.52
Average five showing least gain	....	....	.01

Mention has already been made of the fact that there seemed to be a tendency for the cows to give milk containing a lower percentage of fat when they were returned to Mr. Gibson in the fourth period than they had given in the first period. As to whether this was due to the treatment the cows had received while at the university, we were fortunate in having some evidence from the cows in the original herd that had remained at Mr. Gibson's without change of treatment.

When the cows were returned to Mr. Gibson in the early spring of 1903, there were still in his herd five of the original cows. A record was kept of these cows during the season and it is therefore possible to compare their records in 1900 and 1903 with those of the cows that had been taken to the university. This record, so far as the percentage of fat is concerned, is shown in the following table:

TABLE VI.—RECORD OF THE COWS REMAINING ON THE PRIVATE FARM COMPARED WITH THOSE TAKEN TO THE UNIVERSITY.

NAME OF COW.	Average per cent fat, 1900.	Average per cent fat, 1903.	Gain or loss in 1903 over 1901.
Cows at University, 1901–1902.			
Dena	4.82	5.00	.18
Patty	4.27	4.25	—.02
Polly	5.64	6.25	.61
Rena	3.66	3.44	—.22
Rita	3.92	3.90	—.02
Stella	5.22	4.79	—.43
Tilda	3.71	3.41	—.30
Average	....	....	—.03
Cows at Mr. Gibson's continuously.			
Black Head	4.69	4.44	—.25
Brindle	4.01	3.87	—.14
Pansy	4.24	4.24	.00
Spike Horn	3.84	3.64	—.20
Square Face	4.02	3.97	—.05
Average	....	....	—.13

From the above it will be seen that there was quite a uniform decrease in the percentage of fat in 1903. In fact, the only two cows that gave richer milk in 1903 than in 1900 were Dena and Polly and these were the two cows that were farrow when they were returned to Mr. Gibson, a fact which probably accounts in large part for the increased percentage of fat in their milk in 1903. It would seem, therefore, that the lower average percentage in 1903 could not well be ascribed to any treatment or conditions to which the cows were subjected while at the university.

The Effect on Total Quantity of Milk and Fat.

An inspection of Table III shows that the total yield of both milk and fat was in nearly every case much increased while the cows were at the university. While this was incidental to the main object of the experiment, it has a most important practical bearing, and illustrates most forcibly the capacity of many cows for increased production under more liberal feeding. It is true that in Table III the total record for the whole lactation period is given, and since most of the cows milked longer in 1901 than in 1900 the yields are not readily comparable. We have therefore calculated the yield of each cow in 1900 and 1901 on an average weekly basis for the time she was in milk and the results are given in the table below:

TABLE VII.—AVERAGE WEEKLY PRODUCTION OF MILK IN POUNDS.

COW.	MILK.			FAT.		
	1900.	1901.	Per cent increase.	1900.	1901.	Per cent increase.
	Lbs.	*Lbs.*		*Lbs.*	*Lbs.*	
Chloe	89.8	112.8	25.6	3.8	4.5	18.4
Clover	83.9	121.6	44.9	3.6	5.8	61.1
Dena	83.2	119.8	44.0	4.0	6.5	62.5
Dinah	88.9	122.0	37.2	3.8	5.1	34.2
Patty	106.1	162.2	52.9	4.5	7.8	78.3
Polly	84.9	120.1	41.5	4.8	7.5	56.3
Rena	124.1	175.3	41.3	4.6	6.7	45.7
Rita	113.7	149.9	31.8	4.5	6.5	44.4
Stella	85.4	136.9	60.3	4.4	7.3	65.9
Tilda	103.4	187.0	80.9	3.8	7.0	84.2
Average per cent increase	......	......	46.0	......	......	54.6

Considering the 10 cows, it will be seen that merely through more liberal feeding the yield was increased 46 per cent in milk and 55 per cent in fat. This is the more remarkable when it is remembered that the cows were not selected on account of apparent capacity to improve, but were taken as representative of the whole herd. Attention is also called to the remarkable uniformity of gain in the various individual cows with the exception of Tilda, who made a very large gain, and Chloe who made a relatively small gain; the gains made by the others were very uniform. Referring again to the total yield for the year, it will be seen that eight of the 10 cows produced from 274 to 346 (average 319) pounds of fat within the year in the second period, or the first year under liberal feed. This yield was maintained during the third period, when the ration, though still liberal, was materially reduced; but fell back again to about the original amount when the cows were returned to their former scanty diet.

It is scarcely to be expected that eight out of 10 cows in every similar herd would develop into so profitable animals if given a similar opportunity; but our experience with this herd is sufficient to call attention to the possibility accruing from judicious liberal feeding.

Cost of the Milk and Fat.

In this connection, it is of interest to consider the food cost of the milk and fat under the two systems of treatment. During the time the cows were at the university, the food was weighed daily for each animal so that it is possible to determine accurately the cost of milk and fat. While the cows were at Mr. Gibson's, a careful memorandum was kept of the food and a fairly accurate idea of the cost of milk and fat can be given, particularly for the first year. Since the records in this year closed the first of November, the comparisons of cost have been calculated in each year from the beginning of lactation to November 1.

The following schedule of prices for foods has been used in making these calculations:

Hay	$7 00 per ton
Silage	2 00 per ton
Roots	2 50 per ton
Beet pulp	1 00 per ton
Linseed oil meal, O. P.	30 00 per ton
Cottonseed meal	25 00 per ton
Ground oats	20 00 per ton
Corn meal	20 00 per ton
Wheat bran	18 00 per ton
Wheat middlings	18 00 per ton
Buckwheat middlings	18 00 per ton
Gluten feed	18 00 per ton
Malt sprouts	15 00 per ton
Pasture (including soilage)	30 per w'k

The following table shows the comparative cost of milk and fat for the seven cows that were continued in the experiment, from the beginning of lactation till November 1, for the first, second and third lactation periods. No attempt was made to estimate the cost in the fourth period:

TABLE VIII.—FOOD COST OF MILK AND FAT.

COW.	1900.		1901.		1902.	
	Milk per 100 lbs.	Fat per lb.	Milk per 100 lbs.	Fat per lb.	Milk per 100 lbs.	Fat per lb.
Dena	$0 66	$0 14	$0 66	$0 13	$0 46	$0 09
Patty	50	12	57	12	41	09
Polly	62	11	73	12	48	09
Rena	41	11	53	14	36	10
Rita	49	13	65	15	41	10
Stella	55	11	75	14	46	13
Tilda	51	14	64	17	43	11
Average	$0 53	$0 12	$0 65	$0 14	$0 45	$0 10

Bearing in mind that the cows were fed in 1901 regardless of economy and with the sole idea of getting them to consume as much as possible, the food cost production compares very favorably with that of 1900, while in 1902 a greatly increased production was secured at a decidedly lower cost for food. The increased production was therefore economical on the liberal ration as compared with the scanty one.

Summary.

In a herd of poorly fed cows an abundant ration easily digestible and rather nitrogenous in character and continued through two years, resulted in an average increase of one-fourth of one per cent of fat in the milk (or a percentage increase of about six per cent).

This was accompanied by an increase of about 50 per cent in total amount of milk and fat produced.

The increased production was secured economically so far as the food cost of milk and fat is concerned.

Henry H. Wing.
James A. Foord.

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Department of Entomology

The Grape-Berry Moth

By M. V. SLINGERLAND

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THE GRAPE-BERRY MOTH.

Order LEPIDOPTERA; family TORTRICIDÆE

Polychrosis viteana Clemens

Most vineyardists are familiar with "wormy" grapes. In America the "rogues' gallery" of insect pests now includes three different kinds which have been known to infest grape berries and thus produce "wormy" grapes.

The maggot of a minute Chalcis-fly works in the seeds inside the berries, causing them to shrivel in August; it is known as the grape-seed insect (*Evoxysoma vitis*) and is widely distributed, but it rarely attracts attention by its injuries. In the Mississippi Valley the grub of a small beetle known as the grape curculio (*Craponius inaequalis*) works inside the berries in July, but it is rarely a serious pest. The cause of most "wormy" grapes throughout the United States and Canada is the caterpillar of a small moth—the grape-berry moth—which is always present in most vineyards and often in very destructive numbers.

The grape curculio probably does not occur in New York, and the grape-seed insect has never been injurious in the State. But the grape-berry moth has infested most New York vineyards for many years, often to a serious extent, and it is responsible for practically all the "wormy" grapes. For two or three years this insect has been unusually destructive in several vineyards in the famous Chautauqua grape region, sometimes more than half the crop being ruined. Although during this time we have made important and extensive investigations on the grape root-worm and the grape leaf-hopper (see Bulletins 184, 208, 224 and 215) in Chautauqua vine-

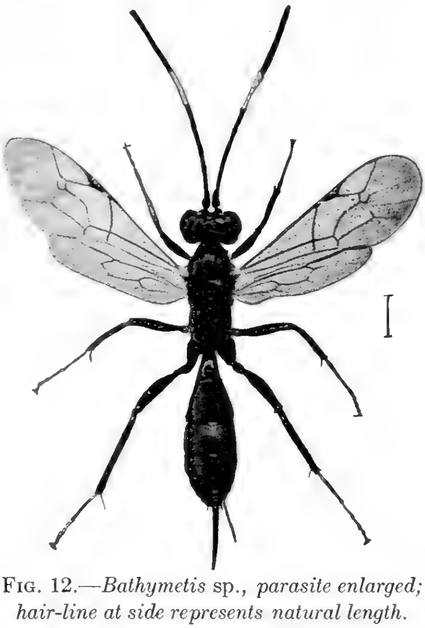

FIG. 12.—*Bathymetis* sp., *parasite enlarged; hair-line at side represents natural length.* (*See page* 52.)

yards, the grape-berry moth also has been studied with many interesting and important results. Our observations, extending over nearly two years and following a complete yearly life-cycle of the insect, have revealed new facts in its life-history; we have demonstrated that it is a native American insect, and not the European grape-berry moth, which all have believed it to be for the past thirty-five years; and through co-operative experiments with several vineyardists in the infested region, we have found practicable and effective methods for controlling the insect.

INDICATIONS OF THE PRESENCE OF THE GRAPE-BERRY MOTH.

Fortunately the vineyardist can easily and surely detect the presence of this insect. Its "signboard" is a purplish spot on the half-grown green berries, which often crack open, as is well shown in Fig. 13. Such spots mean that inside the berry the little caterpillar of the grape-berry moth is at work. No other enemy of the grape in New York State has quite such a "signboard" to indicate its presence. The close observer may also find the insect at work earlier in the season in the clusters of blossoms or young fruits which the little caterpillars web together, as shown in Fig. 19.

APPEARANCE AND HABITS OF THE INSECT BRIEFLY DESCRIBED.

The American grape-berry moth is a small purplish-brown moth which measures not quite half an inch across its outspread wings. The size and general appearance of the adult insect or moth, and the peculiar shaded brown spots on its front wings are well shown in Figs. 15 and 20. So much do these little moths resemble their surroundings when at rest, that it is difficult to find them even in a small breeding cage among pieces of grape vines. And as they doubtless fly mostly at night, the vineyardists will rarely see this grape enemy in its moth stage. The moths are most numerous in New York vineyards about June 1, the middle of July, and again in August.

The minute, scale-like, semi-transparent eggs are stuck onto the berries or their stems. Some of these glistening eggs show like minute, whitish spots on the grapes in Figs. 13 and 16; an egg is shown much enlarged with the unhatched caterpillar inside in Fig. 16. The eggs are not difficult to find on the skin of the berries, but no one seems to have seen them before this time.

In June the little caterpillars which hatch from the eggs of the moths feed among the blossoms or recently-set fruits of the grape clusters, as shown in Figs. 17 and 19. Later in the season when the berries are larger, the caterpillars live inside the berries (Fig. 14) on the pulp and seeds, often going into a second or third berry. They get their growth in from three to four weeks, when they are about three-eighths of an inch long and vary in color from dark greenish to dark purplish with a light brown head and blackish thoracic shield. The arrangement of the sparse covering of whitish hairs and other details are well shown in the enlarged pictures of three full-grown caterpillars in Fig. 18. This grape-berry moth is injurious only during its life as a caterpillar.

When through feeding, the caterpillars leave the berries and cut curious little flaps from the leaves which they pull over and fasten, and inside this they spin a thin, white, silken cocoon. Several of these interesting cocoons were made on the leaf shown in Fig. 22. Two to four days later, the caterpillar transforms in these cocoons into the light greenish-brown pupa, shown enlarged in Fig. 21. During the two weeks spent in this mummy-like pupa state in the summer, the insect is made over or transformed into the adult form—the pretty purplish-brown moth shown in Figs. 15 and 20. After about Aug. 15 all the pupæ hibernate and transform into the moths the next May or June.

There are thus four life-stages in the development of the grape-berry moth—the scale-like eggs (Figs. 13 and 16), the destructive caterpillars (Figs. 17 and 18), the mummy-like pupa (Fig. 21), and the richly colored little moths (Figs. 15 and 20).

IT IS NOT AN EUROPEAN INSECT.

For nearly 35 years it has been the belief that the insect working in the American vineyards was the common grape-berry moth of Europe. In 1870, Dr. Riley sent some of the American moths to Zeller, an expert in Prussia, who reported that they were the European grape pest, known as *Eudemis botrana.** No one seems to have ever confirmed or even doubted Zeller's dictum and the American insect has since borne the European name.

In making a critical study of the literature in 1903, we were surprised to find that in European records the grape-berry moth pupæ hibernate in cocoons on the trunk of the vines or on the trellis posts, but in all American records, where hibernation is mentioned, it is said to take place in cocoons on the fallen leaves. After searching for several hours in a badly infested New York vineyard in autumn and finding cocoons on the fallen leaves, but none elsewhere, we

*Riley in Am. Ent., ii, p. 273; and Zeller in Stett. Ent. Zeit., vol. 32, p. 178.

suspected that the grape-berry moth of America might be after all a native and not a foreigner.

Some of the European moths were obtained and a critical comparison and study, as detailed later on (see Fig. 24), has demonstrated that our American moth is a different species, and furthermore that several other kinds of American moths have been placed together in our collections as the European grape-berry moth. In superficial appearance and in its habits our American grape-berry moth is much like the European species, but they are certainly distinct species and readily separable. We also find by breeding that the moth which frequently infests American wild grapes is the same as the one working in the vineyards; this is quite conclusive evidence that the insect is a native and not an imported species.

SOME HISTORICAL NOTES.

The American grape-berry moth has been known since Clemens named the moth in 1860, but it was not recorded as injurious until 1868 in Ohio, Missouri and Pennsylvania. During the next year or two, it was destructively abundant in vineyards in Illinois and Maryland. The first record we have found of the insect in New York† states that it seemed to be increasing in the Hudson River Valley in 1873. In 1881, it was again abundant in Missouri and the next year in Ontario, Canada. There was a serious outbreak in Illinois again in 1884 and 1885, and in 1889 it was injurious in Delaware. It was apparently first recorded working in wild grapes in 1895 in Nebraska. From 1897 to 1899 one of our correspondents at Kendall, N. Y., reported serious injury in his vineyards from this insect, and it was also very destructive in northeastern Pennsylvania and Ohio vineyards. For the past two or three years the grape-berry moth has continued its destructive work in Ohio, Pennsylvania and Virginia; and in many vineyards scattered throughout the famous Chautauqua grape region a large percentage of the crop has been ruined by the insect.

DISTRIBUTION AND DESTRUCTIVENESS OF THE INSECT.

The American grape-berry moth is widely distributed throughout the United States and Canada, probably occurring wherever the grape is grown to any extent, from the New England States to Florida and Texas and westward to California. It has been recorded in injurious numbers in Canada, Ohio, Illinois, Missouri, Pennsylvania, New York, Delaware, Maryland, Virginia and Texas.

This insect ranks first in destructiveness among the pests attacking the grape-berry. There have been but few definite estimates of the amount of injury by it. In 1869 it is said to have ruined 50 per cent of the fruit of certain varieties in Ohio, and in the same locality half the crop in many vineyards was rendered unmarketable in 1897 and

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†*Meehan's Gardener's Monthly*, **xv**, 121.

1898. A correspondent reported to us that the crop was entirely ruined by the insect in some vineyards in 1896 at Northeast, Pa. In 1903 the fruit in a Catawba vineyard of 16 acres in Ohio was so badly infested that it was unfit for use, even in making wine. The grape-berry moth is doubtless in most of the vineyards of the country every year, and the above records show that it is capable of ruining the crop of fruit.

In New York.—There are doubtless more or less "wormy" grapes each year in practically every vineyard in New York State, so that the grape-berry moth is a constant menace. But it seems seldom to have been injurious since 1873 when it was first reported as increasing in numbers in the Hudson Valley. In 1898 it was a serious pest in the vineyard of a correspondent at Kendall, N. Y., and in 1902 reports reached us of its ravages all through the Chautauqua grape belt. From portions of some vineyards near Brocton, a loss of from 25 to 50 per cent was reported, and in one case 90 per cent of the fruit was ruined. In 1903 and during the past year, the insect wrought equally as great destruction over a larger area in Chautauqua county. Many grape clusters were badly injured soon after the fruit was set, as shown in Figs. 17 and 19, and last July one could easily find clusters in badly infested vineyards with more than two-thirds of the berries "wormy." Thus the conditions are alarming in many vineyards in the Chautauqua region. In none of the other noted grape-growing sections of the state does the grape-berry moth seem to have attracted attention as a pest in recent years.

THE FOOD-PLANTS OF THE GRAPE-BERRY MOTH.

When the American grape-berry moth was first described and named by Clemens in 1860, he recorded the caterpillars as feeding on the fruit of the grape and wild raspberry, and on the leaves of sassafras. When the insect attracted attention as a grape pest in 1868, it was erroneously recorded as feeding on the leaves as well as the fruit of the grape* and the error has clung tenaciously to the literature ever since. During the next 30 years, there was added to the menu of the grape-berry moth the following food-plants: blackberry blossoms† (Riley, 1870), roses and *Vernonia* or ironwood (Murtfeldt,

*Packard first made this error (Am. Nat., II, p. 220, and part V, p. 336 of *Guide to the Study of Insects*) in 1868, but both Packard and Riley corrected it the next year (Am. Nat., III, p. 152, and Am. Ent., I, p. 177.) Yet the statement was never corrected in future editions of Packard's *Guide*, and the insect has been said by nearly every writer to feed on grape leaves.

†Mr. W. D. Kearfott writes us that this blackberry feeder is a quite different moth known as *Ancylus muricana* Wlsm.

1880 and 1882), tulip-tree leaves and swollen stems of *Amorpha* (Fernald, 1882), flower-buds of common thistle (Coquillett, 1883), berries of wild grape (Bruner, 1895), grape tendrils and blossoms, seed bunches of sumac, leaves of magnolia, phylloxera lice and their galls (Martlatt, 1896), and moths bred from flower-heads of thoroughwort or boneset and *Ambrosia trifida* have been classed with the grape-berry moth in collections. This is certainly quite a varied menu for a grape pest.

We have never seen the insect eat anything but grape blossoms, recently-set fruit, rarely the stem of clusters, and the green and ripening grapes. And a critical study of the supposed grape-berry moths in several collections has led an expert, Mr. W. D. Kearfott, to believe that those found feeding on most of the plants other than the grape are different species. A detailed account of Mr. Kearfott's interesting conclusions with illustrations is given on page 57. The case of sumac as a food-plant is especially important, as it often grows freely in the vicinity of vineyards, and its destruction has been recommended as a help in the warfare against the grape-berry moth. Webster, however, bred many supposed grape-berry moths from seed bunches of sumac collected in 1898 with no vineyards near, and the seeds collected near seriously infested vineyards gave none of the moths. Now Mr. Kearfott finds that these sumac moths of Webster's are a distinct species from the grape feeder.

We expect that a thorough study of the supposed grape-berry moth which feed on other plants than the grape will reveal the fact that the true American grape-berry moth restricts its diet almost entirely to the blossom and fruit clusters of both the wild and cultivated grapes. Apparently no varieties are exempt from its attacks; those with tender skins and such as grow in compact bunches sometimes suffer most. The infested vineyards in the Chautauqua region are mostly Concords.

THE LIFE-HISTORY OF THE INSECT.

The life-history of the grape-berry moth has many interesting features, and we have been able to follow it through a complete yearly life-cycle during the past two years. We can now substitute definite facts for previous guesses and also add several chapters to its life-history.

Hibernation.—In Europe the grape-berry moth has long been recorded as hibernating in cocoons on the trunks of the vines, or on the trellis posts; but since 1868 it has been the common notion in this country that what was believed to be the same insect hibernated in cocoons on the fallen grape leaves. The loose bark on the vines or trellis posts affords ideal places for hibernation, but after several hours careful searching in such places in a badly infested vineyard in the autumn of 1903, we failed to find a single grape-berry moth. But we did find quite a number of the pupæ in their characteristic cocoons on the fallen leaves beneath the vines. This divergence in the hibernating habits in the two countries was easily explained when further study revealed the fact that the American grape-berry moth is not the European insect with similar habits, although very closely related to it.

The winter is always passed in the pupa state in the cocoon. We found most of the cocoons in the autumn on the damp and decaying leaves close to the ground under the vines, rather than on the drier leaves which are often blown into piles. There were also indications that some of the cocoons soon break away from the decaying leaves. These facts may explain why some have failed to breed the moths from leaves collected, probably from convenient piles in vineyards. In our breeding cages in autumn all the caterpillars spun their cocoons on the grape leaves rather than on the pieces of grape-vine, except one which cut its peculiar cocoon from a thin flap of the bark.

Appearance and work of the spring brood.—In a cage of hibernating pupæ that we kept outdoors, no moths appeared in the spring, and the pupæ got mouldy. But from pupæ kept in the warm insectary all winter, the moths were doubtless forced and began to emerge March 19 and continued until April 14. Thus we missed the normal time of emergence of the moths in the spring, but as recently-hatched caterpillars were found at work in the vineyards on June 17, some of the moths are doubtless flying by June 1, in the Chautauqua region. The eggs laid by these moths were not observed, but they are probably stuck on the stems of the blossom clusters.

Some of the caterpillars hatch and begin feeding before the grape blossoms open. They make a slight web among the blossom buds into which they eat, oftentimes destroying a dozen or more embryo grape-berries. The destructive work of this spring brood of caterpillars continues in June through the blossoming period and among the recently set berries, as shown in Figs. 17 and 19.

One caterpillar may destroy more developing fruits in June than half a dozen caterpillars working in the larger berries later in the season. Yet this spring brood of the grape-berry moth and its work rarely attract attention. This is doubtless largely because the slightly webbed portions of the clusters of blossoms or young fruits do not make infested clusters especially conspicuous, and the spring brood is also comparatively small. In a vineyard badly infested in 1903, we found in June the next year not more than two or three caterpillars on a vine and many vines had no infested clusters. Three caterpillars were found in one cluster, and sometimes from one-third to one-half of the recently set berries on a cluster were destroyed by a single caterpillar. The smallness of the spring brood is due largely to the efficient work of the many parasitic enemies of the insect the preceding year, doubtless aided often by unfavorable winter conditions.

We have never seen the spring brood of caterpillars feeding anywhere except on the grape clusters, but the leaves and tendrils have been recorded in their menu at this time. In a few instances we have found where the caterpillars had burrowed into the fruit stem causing the end of the cluster to die, but their usual menu in June consists of the blossoms and young grape-berries. The caterpillars of the European grape-berry moth have similar feeding habits in the spring.

It is an important fact that the first or spring brood of the caterpillars do not live inside the small blossoms and berries, but feed openly on the outside. For this offers a vulnerable point for effectively attacking the insect with a poison spray, as our experiments have shown.

By July 1 many of the caterpillars have attained their full size. They go onto the leaves where they make their peculiar cocoons, as shown in Fig. 22. A little flap is cut from the leaf and gradually pulled over and down and fastened to the leaf by silken threads. The inside is then lined with white silk, thus forming a snug cocoon. At the edge of a leaf, it is necessary to cut the flap only at the ends; but when the cocoon is made away from the edge, the flap must be cut along one side also, and frequently the caterpillar cuts along where the edge of the flap is to meet the leaf and pulls up the leaf a little to meet the flap. Fig. 22 well illustrates these variations in cocoon-making. In three or four days, the little caterpillar transforms inside its cocoon into the greenish-brown, mummy-like pupa stage (Fig. 21). During the first week in July, many of the spring brood of caterpillars pupated, and in from 12 to 14 days the moths had developed and began to emerge. By means of the spines on its back (Fig. 21), the pupa is enabled to work its way nearly out of one end of its cocoon, and the moth then emerges, leaving the empty pupa skin projecting from the cocoon.

We reared moths from caterpillars of the spring or June brood on July 16 to 18, but they must have begun to appear earlier, for recently-hatched caterpillars were found in the grapes in vineyards on July 14.

The summer brood and its habits.—During July and August all of the four stages of the grape-berry moth can be found in the vineyards at the same time, for the different broods overlap. What may be termed the second of summer brood of caterpillars works during the latter half of July and in August.

The July moths or parents of this brood lay their eggs on the skin of the green berries or on the stems.* The embryo caterpillars can be seen through the semi-transparent shell of the egg, as shown in Fig. 16. Several eggs may be laid on the same grape, and are quite easily found. We seem to have been the first to find them. The number of eggs a moth may lay has not been determined, nor the duration of the egg-stage. The European grape-berry moth is estimated to lay from 20 to 40 eggs which hatch in about a week.

A caterpillar which we saw hatch about 5:00 p. m., on July 26, wandered around on the grape-berry for nearly 17 hours, when it finally gnawed its way into the fruit at the point where the stem is attached. It fed inside the same grape until its death August 13, when it was about half-grown. Many of the newly hatched caterpillars enter where berries touch each other. A dark-reddish spot soon appears on the green fruits around the entrance hole, and as the caterpillar feeds in the pulp this dark spot enlarges until nearly half of the berry is often involved. The young caterpillars are whitish with a blackish head. As they grow, the shield on the thorax and the six true legs become blackish, and the whole body changes to a dark green, often with a purplish tinge (Fig. 18). The caterpillars are very active, and when disturbed quickly wriggle out of the grapes and suspend themselves by a silken thread.

In our cages, caterpillars which hatched about July 25, got their growth inside the grapes in three weeks and spun their cocoons August 17. Many of the moths developed from this second or summer brood of caterpillars in the grapes emerged from August 15 to 28 in our cages.

The most conspicuous and destructive work of the grape-berry moth is done by this second and most numerous brood of caterpillars working in the growing, green grapes in July and August. Vineyardists can readily see the characteristic purplish spots on the infested fruits, which often crack open at this point (Fig. 13), and thus afford an ideal lodging place for the spores of the destructive rot fungi.

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*The thin, rounded, scale-like, semi-transparent eggs measure .6 to .8 by .7 to .9 millimeters in size, and appear whitish in a few days. The shell is finely reticulated, as shown in Fig. 16, and the egg appears to be glued to the fruit by some substance. The egg looks much like a codling-moth's egg, only smaller.

In some badly infested vineyards we found many clusters with over three-fourths of the berries infested. Oftentimes the caterpillar goes from one berry to another, fastening them together with a few silken threads. To determine how many berries one caterpillar usually spoils, we put in our cages on July 30, two clusters each containing 17 grapes infested by young caterpillars; by August 15, there were 25 and 29 "wormy" grapes in the clusters. This experiment and other observations indicate that one caterpillar rarely destroys more than two green grapes in summer, and one berry often furnishes sufficient food. Every infested berry helps to spoil the symmetry of the clusters and necessitates the labor of removing such berries before marketing the crop, except where they can be sold cheap for wine. Several vineyardists have demonstrated the practicability of picking off the infested green berries when they are conspicuous in August.

When the summer brood of caterpillars get full-grown in August, they all go onto the leaves and cut out their characteristic cocoons, as shown in Fig 22. In our cages the caterpillars would wait for several days and sometimes die before transforming, if leaves were not supplied them for cocoon-making.*

A partial third brood in autumn.—By August 1, many of the caterpillars of the second brood have changed to pupæ in their cocoons on the leaves. In from 12 to 14 days the pupæ transform and the moths emerge. We reared many moths from August 15 to 20 and most of them emerged in the forenoon, but all came from cocoons made before August 15. It seems that all caterpillars of the summer brood which pupate after about the middle August do not transform to the moth state that year. In other words, part of the second brood of pupæ hibernate, and part develop into moths to produce a partial third or autumn brood of caterpillars which work in the ripening grapes. This third brood is not nearly so large as the second, and as many of the fruits infested by the latter drop off before the fruit ripens, oftentimes the infestation does not seem as bad at picking time as in August, but the clusters are more ragged. Most of the caterpillars are full-grown before October 1, but some were found working in very ripe fruit two weeks later. A few caterpillars transform in autumn to pupæ inside the berries they infest, but most of them make their

*The pupæ are 5 millimeters ($\frac{3}{16}$ inch) in length and of a light greenish-brown color, with eyes and caudal border of abdominal segments and last two or three segments darker brown. There is a row of coarse, short spines near the cephalic border, and a row of finer ones along the caudal border of the dorsum of each abdominal segment; and eight bristles with recurved tips for hooking into the silken cocoon occur around the tip of the abdomen.

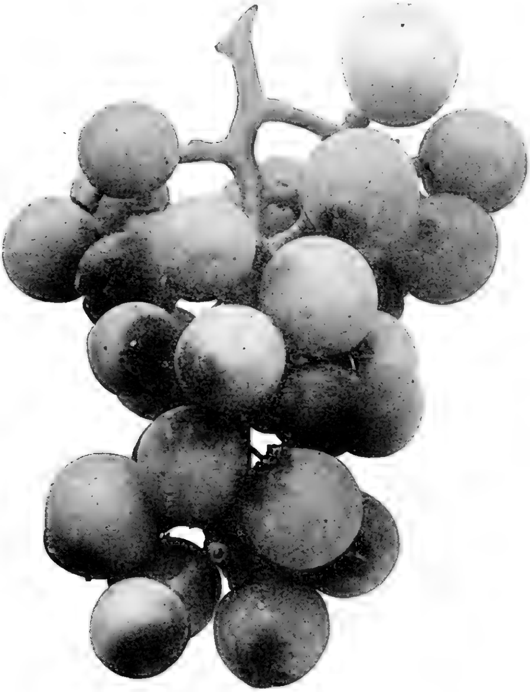

FIG. 13.—*Cluster of green Concord grapes badly infested by the grape-berry moth, natural size. Note the discoloration and cracking open of the infested berries; the round, white eggs of the insect can be seen on some of the fruits.*

FIG. 14.—*The grape-berry moth caterpillar and its work in the pulp and seeds, enlarged.*

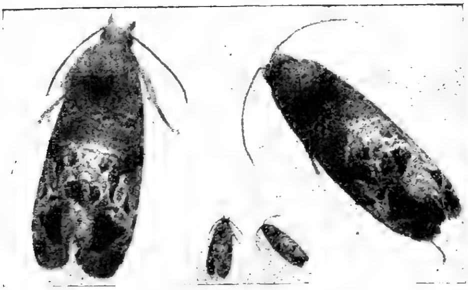

FIG. 15.—*American grape-berry moths at rest, natural size and enlarged.*

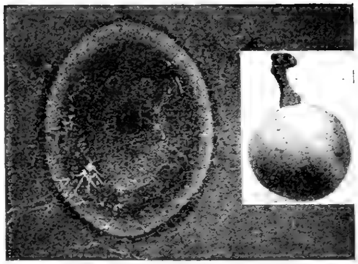

FIG. 16.—*Eggs, natural size on the grape, and enlarged.*

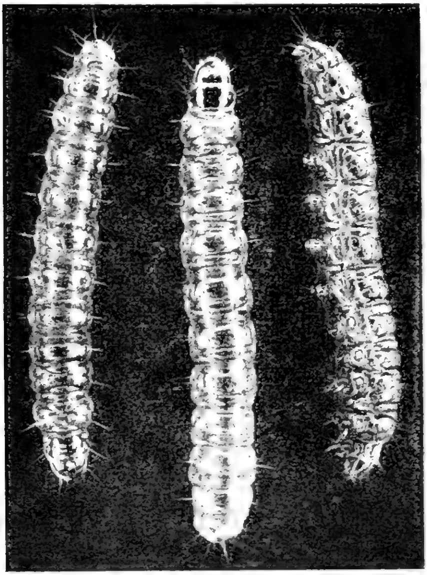

FIG. 17. *Grape-berry moth caterpillars working among young fruits, twice natural size.*

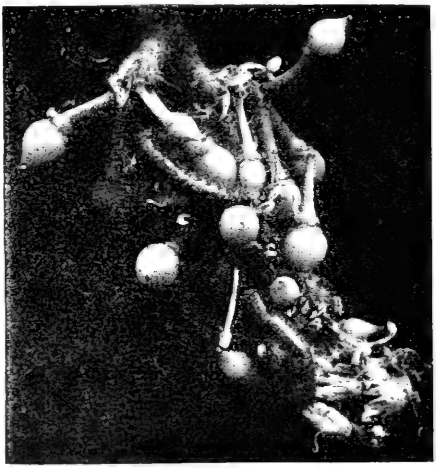

FIG. 18.—*Grape-berry moth caterpillars, enlarged.*

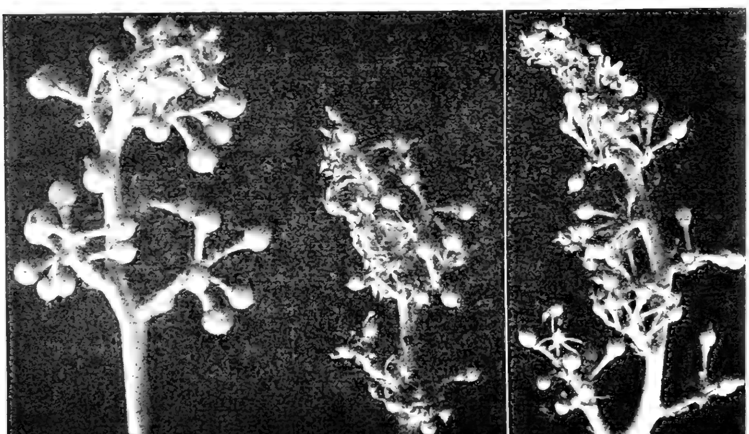

Fig. 20.—*American grape-berry moth, enlarged; shown natural size in lower corner.*

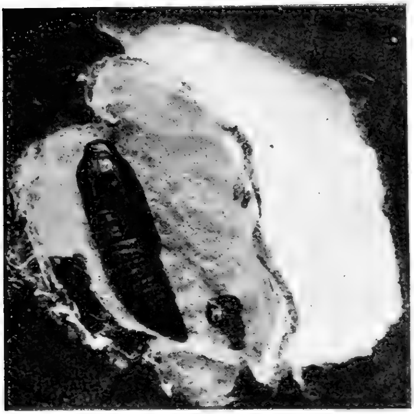

Fig. 21.—*Grape-berry moth pupa in its cocoon on flap of leaf, enlarged.*

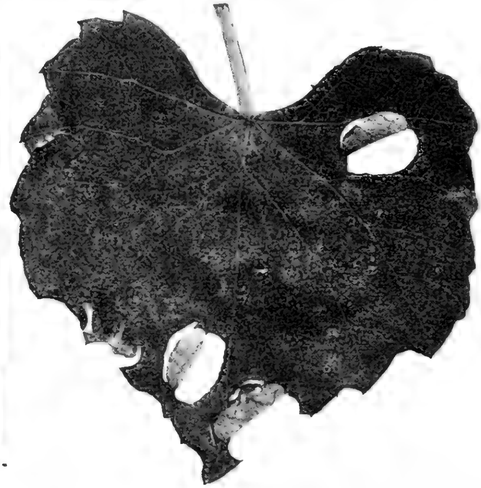

Fig. 22.—*Grape leaf showing cocoons in the making and finished by grape-berry moth caterpillars, natural size.*

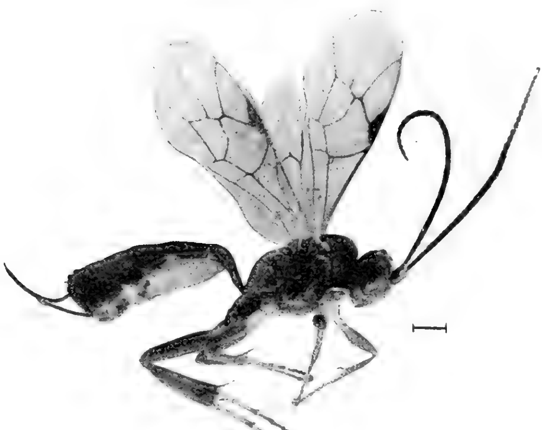

Fig. 23.—*Thymaris slingerlandana* Ashmead, *a common parasite of the grape-berry moth. Enlarged, the hair-line showing its natural length.*

European.
Polychrosis botrana Schiffermüller.

American.
Polychrosis viteana Clemens.

European.
Polychrosis botrana Schiffermüller.

Polychrosis rhoifructana Kearfott.

Polychrosis slingerlandana Kearfott.

Polychrosis liriodendrana Kearfott.

FIG. 24.—*The European and American grape-berry moths compared, and pictures of three new species of moths allied to and heretofore confused with the American grape-berry moth.*

characteristic cocoons on the leaves, like the earlier broods. Our observations indicate that the insect always passes the winter in the pupa state in its cocoon on the fallen leaves near the vines.

The European grape-berry moth has three broods in Italy and its habits are very similar to the American insect during the growing season. But in autumn the European caterpillars, instead of making their hibernating cocoons on the leaves or in the fruits, as they do in summer, go onto the trunks of the vines and the stakes or trellis posts, where underneath the bark they make their thicker, winter cocoons. We failed to find any hibernating cocoons of the American insect in New York vineyards except on the fallen leaves.

THE NATURAL ENEMIES OF THE GRAPE-BERRY MOTH.

Fortunately for the vineyardist, we have discovered that the grape-berry moth has many enemies among its own kind, which play a very important part in its "ups and downs." Undoubtedly these insect enemies, aided by winter weather conditions, are largely responsible for the comparatively small size of the spring brood of this grape pest.

In August, 1903, several caterpillars were found in the grape-berries that were being attacked externally by a whitish maggot, which soon spun a little, white, silken cocoon after sapping the life of its victim. From several of the cocoons kept in our breeding cages during the next winter, there emerged in May and June two kinds of little parasitic flies instead of the expected grape-berry moths. Then in the spring of 1904, we found in the webbed blossom-clusters several cocoons of another parasite, which had doubtless destroyed the caterpillars feeding on the blossoms. Later that season, we found that many of the caterpillars of the second or summer brood never developed into the moths, for little parasitic flies came from their cocoons in August.

The grape-berry moth is therefore beset by insect enemies during the development of each brood and at all seasons of the year. We have bred the unusually large number of six different kinds of parasitic flies, which must materially help the vineyardist in his warfare against his enemy. This was a surprising discovery, for heretofore only a single enemy of this grape pest had been recorded in America.*

*Two parasites, a Pimplid (*Phytodietus pleuralis* Cress.) and a Braconid (*Bracon vernoninae* Ashm.) have been recorded (Insect Life, II, 349, and III, 404) on *Eudemis botrana* in this country. But the former was bred from tulip-tree and the latter from seed capsules of *Vernonia;* and the host insects feeding on these plants are now believed to be distinct species from either the European or the American grape-berry moths. The one working on tulip-tree leaves is described on page 58 as *Polychrosis liriodendrana* by Mr. Kearfott. However, it is quite probable that these two parasites also include the American grape-berry moth among their hosts; and thus should be added to the list of its insect enemies.

Four of these little parasites are little Ichneumon flies and two are Braconids. Four of them were not new to science, but one, and possibly two, proved to be new species. The one which we reared in largest numbers and which thus seems to be the most effective check on the grape-berry moth has been burdened with our name. It is now known to science as *Thymaris slingerlandana* Ashm. and is shown much enlarged in Fig. 23. Dr. Ashmead reports that this is the first American species to be described in this genus.

The following notes regarding these parasitic enemies of the grape-berry moth are worth recording:

In 1869, Riley found two maggots destroying the caterpillars in Missouri, but he failed to breed the adult parasite. We find no other record of any enemy of the insect in America. Riley's description of the habits of this parasite does not fit any of those we have seen, but comes nearest to one of the Braconids.

Bracon scrutator Say. (Boston Journ. Nat. Hist., I, 254). The maggot of this little Braconid parasite seems to feed externally on the nearly full-grown caterpillars of the second brood at work in the green fruit in August. Their little, white cocoons are spun in the infested berries. The adults emerged in about two weeks on the following dates: Aug. 28, Sept. 1, 4 and 10.

Bathymetis sp. near *terminalis* Ashm. We reared two females of this comparatively large parasite (Fig. 12, p. 103) from hibernated pupæ on May 31. The grape-berry moth caterpillar had pupated and the parasite's cocoon filled that of its host. Dr. Ashmead reports our specimens as probably undescribed, but possibly *terminalis*, which was described from a male only.

Glypta animoso Cress. (Trans. Am. Ent. Soc., III, 154). One specimen of this Ichneumon emerged from an over-wintered cocoon on June 4. It spun a very thin cocoon and had evidently killed the caterpillar, as no trace of a pupa was found. The recorded hosts of this parasite are *Paedisca scudderiana*, two other Tortricids and a Pyralid.

Glypta vulgaris Cress. (Trans. Am. Ent. Soc., III, 157). Two specimens of this common parasite emerged on August 25 and 27 from thin, white cocoons nearly filling their host's cocoon in a wild grape. Like *Glypta animosa*, this species evidently kills the caterpillar, but it works on the summer brood. It is also parasitic on a species of *Gelechia* and on a Pyralid (*Margaronia quadristigmalis*).

Urogaster canarsiae Ashm. (Ent. Soc. Wash., IV, 127, with figure). Found the cocoons of this probable parasite in the webbed blossoms where grape-berry moth caterpillars had worked. Two specimens emerged on July 3 and 7. Evidently parasitic on the first or spring brood. Its other known host is the Pyralid (*Canarsia hammondi*).

Thymaris slingerlandana Ashm. (Can. Ent., XXXVI, Nov., p. 333). From August 15 to 27, we reared 17 specimens of this little back Ichneumon with orange-colored, light yellow-banded legs from the cocoons of the grape-berry moths working in both wild and cultivated grapes. Its cocoon occupies about half the space inside the host's cocoon, and evidently the caterpillar was its victim.

The European grape-berry moth (*Polychrosis botrana*) is preyed upon by eight Ichneumons closely allied to our American parasites, one Dipteron, one spider and two fungous diseases (Nuove Relazioni R. Stazione di Entomologia Agraria di Firenze, Serie Prima, No. 1, p. 152–162).

REMEDIAL TREATMENT FOR THE GRAPE-BERRY MOTH.

At least three times during its yearly life-cycle, this insect is vulnerable and can be effectively fought.

Destruction of fallen leaves.—The most frequent recommendation has been to gather and burn the fallen leaves in autumn or winter, and thus destroy the insect in hibernation as a pupa in its cocoon on the leaves. This method is correct in theory and practicable on a small scale, and might help materially in controlling the insect. But our experience in hunting for the hibernating cocoons indicates that many soon break loose from the fallen and rotting leaves on the ground, and thus are not carried by the wind with the drier leaves into the piles which usually accumulate. The failure also of some to breed the moths from the leaves, probably collected from piles in infested vineyards, leads us to rank this among the least effective methods, and one often impracticable in a large vineyard.

By cultivating early, especially along the trellis under the vines, one would doubtless bury and destroy some of the hibernating pupæ.

Bagging the clusters.—The practice of putting paper bags around each cluster of grapes soon after they set, will doubtless protect them from attack by the second and third broods of the insect, as well as from other insects and rot fungi. Hundreds of thousands of choice grape clusters are thus "bagged" every year in New York vineyards, and it pays.

Picking the infested berries in August.—Probably the method most often used against the grape-berry moth is to pick off and destroy the characteristic and conspicuous, spotted green fruits infested by the caterpillars. This destroys the very destructive second brood, thus preventing the further development of the insect that season, and it is a very effective method. To test the practicability of this hand-picking method on large areas, some of the Chautauqua vineyardists co-operated with us and made the experiment in 1903 and 1904. It was found to cost only about $2 to thus go over an acre of vineyard and pick off the infested fruits in August. An acre yielded from 30 to 50 pounds of "wormy" grapes. The expense was small for such a very effective method. Boys and girls could do the work well and cheaply, and we strongly commend this sure method, especially as the infestation is usually serious only over a portion of a vineyard.

Destruction of "trimmings."—Oftentimes the grapes are sorted and "trimmed" for the market in the vineyard. All the "wormy" or bad berries are removed and often left on the ground where the "worms" can develop into a destructive crop of the insect for the next season. Many a local infestation in a vineyard doubtless can be traced back to such packing or sorting spots. Care should be taken to collect and bury or burn all such "trimmings" from the grape clusters. It will repay the slight extra expense many times over.

Destroying sumac and other supposed food-plants.—That part of a vineyard nearest woodlands, or perhaps a lot of sumac, is oftentimes more infested by the grape-berry moth. And as the insect was supposed to breed in sumac seed-bunches and on various other plants, some have considered the destruction of such plants a helpful remedial measure. But we have shown in discussing the food-plants of this insect, that it now seems quite probable that it feeds exclusively on grapes. Undoubtedly a large clump of sumac or other plants, or an old brush-grown fence, near a vineyard, would afford a convenient place for a pile of grape leaves to accumulate, and thus might afford the insect better hibernating quarters. The removal of such useless plants or unsightly fences near vineyards is always advisable, but it may help but little in reducing the numbers of the grape-berry moth.

Poison sprays are effective.—About nine years ago, the use of a poison spray was suggested for combating this insect.* It was said to be practicable only against the first brood, which was supposed to develop on the green parts of the vine, and here the results would be doubtful, for the insect was more than likely to breed on a great variety of foliage, and thus spraying would not afford much protection. By 1898, however, the vineyardists of northern Ohio, who were then fighting the grape root-worm, had found that they were controlling the grape-berry moth by spraying with poisons early in the season, soon after the grapes had set, when the first brood of caterpillars work on the outside.†

The vineyardists in Chautauqua county who co-operated with us in the experiments in picking off and destroying the infested green berries in August, also sprayed infested parts of their vineyards in 1903, and during the past season with the arsenate of lead. In one case the poison was applied at the rate of 10 and 12 pounds in 100 gallons of water, the first application being made just before the blossoms opened, a second application just after the petals of the blossoms fell, and a third when the berries were about the size of small peas. The vineyardist reported that these applications gave almost absolute protection from the insect during the rest of the season. Another grower who sprayed a little later this season with "Disparene" at the rate of eight pounds in 90 gallons of Bordeaux

* Marlatt in Yearbook of the U. S. Dept. of Agriculture for 1895, p. 404.

† Webster in Rept. Ohio Hort. Soc., for 1898, p. 3.

mixture reports very few "wormy" grapes. Dr. Felt also reports 50 per cent less fruit damaged by grape-berry moths where arsenate of lead and also a poisoned Bordeaux mixture was applied in 1903 for the grape root-worm beetles shortly after blossoming and while the fruit was not larger than a small pea.*

The above evidence in favor of the effectiveness of a poison spray for the grape-berry moth leads us to strongly advise its use in infested vineyards. Probably any of the standard poison sprays will do effective work, but we like the arsenate of lead best. With this poison there is no danger of injuring any part of the vine; it sticks on longer than other poison sprays; and we have demonstrated its effectiveness against the grape root-worm beetles (Bull. 224) which need to be fought about the same time as the grape-berry moth. Thus with this poison spray, the vineyardist can hit two serious insect enemies at the same time, and by combining the arsenate of lead with Bordeaux mixture, a very effective blow can be dealt to rot and other fungous troubles.

The poison spray is effective only against the spring brood of caterpillars working in the blossoms and recently-set fruit clusters, where they must work on the outside, and can thus eat the poison. Two applications are advised, at the rate of about four pounds of the arsenate of lead or "Disparene" in 50 gallons of water or Bordeaux mixture. Spray first just before the grape blossoms open in the latter part of June; make a second application just after the petals of the blossoms fall. Doubtless a third application of the poison will pay when the berries are about the size of grape-seeds. Only thorough work will pay in spraying vineyards. Aim to cover every fruit cluster and all the foliage with the poison and Bordeaux, thus hitting the grape-berry moth caterpillars and rot fungi on the clusters, and the root-worm beetles and mildews on the leaves.

European methods.—The closely allied grape-berry moth which infests European vineyards does not differ in its feeding habits from the American species, so the same remedial measures should prove effective during the growing season. Laborers in Europe are sometimes trained to carefully pick out or crush the first brood of caterpillars working in the blossom clusters. This is practicable in our country when very observant help is obtainable. Hand-picking of infested green grapes later in the season is also much practiced in Europe.

A spray of soft soap, alcohol, and benzine is strongly recommended in Europe for hitting and killing the caterpillars in their webs among the blossoms in spring. Others report good results with a 3 per cent soap solution. The former would be too expensive a spray for American vineyards, and our cheaper poison spray is also very effective against some of the other enemies at the same time.

As the European insect hibernates in cocoons on the trunks of the vines and on the trellis posts, it is effectively combated by stripping off the loose bark in

*Bull. 72, N. Y. State Museum, p. 31 (1903).

winter and destroying the pupæ on this and in all cracks or similar places. This method is not applicable in America, for our insect does not hibernate in such places, but on the ground on the widely-scattered leaves.

COMPARATIVE NOTES ON THE AMERICAN AND EUROPEAN GRAPE-BERRY MOTHS.

In 1860, Clemens (Proc. Acad. Nat. Sci. of Phila., p. 369) named some moths *Endopiza? viteana* which he reared from caterpillars feeding on grape-berries, wild raspberry fruits, and leaves of sassafras. About eight years later, the grape-feeder attained the rank of a serious pest in vineyards, and two other names were suggested for it. Rathvon (Prac. Farmer, Nov. and Dec. 1868, p. 170 and 48) called it the grape codling-moth (*Carpocapsa vitisella*) and Packard gave it the name of *Penthina vitivorana* (Guide to the Study of Insects, p. 336). In 1870 however, Riley sent specimens to Zeller in Prussia, and he said they were identical with the European grape-berry moth (*Eudemis botrana* Schiff.), thus relegating the American names into the synonomy where they have since remained undisturbed. As soon as we found that the insect infesting New York grape-berries was not following the scheduled life-history of the European pest, doubts at once arose regarding the identity of the American and European grape-berry moths in spite of Zeller's dictum which had stood unquestioned for over thirty years. Several authentic specimens of the European moths were obtained and have been critically compared by an expert, Mr. W. D. Kearfott, with dozens of the moths reared from American grapes, both wild and cultivated, and also with the type specimens of Clemen's *viteana* and some of Riley's material. Briefly stated, the conclusion is that the American grape-berry moth is Clemen's *viteana*, which is distinct and easily separable from the European insect. This conclusion, based on a comparison of the moths alone, is strongly supported by our observations on the difference in the life-history of the two insects, and the fact that the American insect freely infests both our wild and cultivated grapes.

The general coloration of the moth of the European insect (Fig. 24) is an ashy gray with pale grayish hind wings, while the American moths range a trifle smaller, and are of a general purplish-brown color with smoky-brown hind wings. And the large outer marginal patch near the fringe of the front wings affords a sure and easy distinguishing mark between the two insects. In the European *botrana*, the outer edge of this pale olive-green patch is rounded and not indented below, while in the American *viteana* this dark-brown patch is indented above the anal angle by a spur of the lighter ground color of the wing. This characteristic difference is well shown in Fig. 24. There is considerable variation in the indentation of this patch in *viteana*, but it is always present; we have a few specimens where the indentation extends through the patch, thus making it smaller and separating off a narrow strip of it on the edge of the wing, but this usually occurs on one wing only, the other being nearly normally indented. Superficially the two insects are marked much alike, but are easily distinguished by the characteristic differences in general coloration and the outer marginal patch. Both species are somewhat variable in size and markings, as is shown in Figs. 20 and 24.

An excellent, detailed, 75-page account by G. Del Guercio of the European grape-berry moth was published in 1889 (Nuove Relazioni R. Stazione di Entomologia Agraria di Firenze, Serie Prima, No. 1, p. 117–193). In a careful comparison of specimens of the early stages of our American species with Guercio's descriptions, we found but few minor differences.

DESCRIPTIVE NOTES ON SOME NEW SPECIES OF AMERICAN MOTHS THAT HAVE BEEN CONFUSED WITH THE GRAPE-BERRY MOTH.

BY W. D. KEARFOTT

The following notes are from breeding records extending over the past four years, which have convinced me that each of the species described, as well as a number of others waiting for better material, completes its entire yearly cycle of two or three broods on a single food-plant, and also with little doubt each food-plant supports a separate and distinct species. This does not seem unreasonable, for in Europe there are twenty described species in the genus *Polychrosis.*

Synopsis of species.—

1. With large outer marginal patch of front wing indented above anal angle by a spur of ground color 2
   With this patch evenly rounded on outer edge, not indented below . . . . *botrana*
2. With inner half of front wing uniformly lilaceous or leaden-blue, crossed by well-defined narrow brown lines 3
   With inner half much mottled with reddish brown or gray 4
3. With ground color of outer half of front wing rich ochreous-brown . . . . *liriodendrana*
   With ground color of outer half of front wing pale yellowish-brown . *viteana*
4. With dark color of central fascia of front wing extending to dorsal or inner margin . . . . *rhoifructana*
   With this dark color concentrated about and above middle of wing, and not reaching dorsal or inner margin . . . . *slingerlandana*

It is not unlikely that the European *botrana* is or may become established in America, although of all the specimens examined I have not seen a single one that could be referred to it, hence it is included in the synopsis and a brief description added. On the other hand it would not be surprising if the American *viteana* should at some time be introduced into Europe.

Polychrosis botrana Schiffermüller.—Front wing: ground color ashy-gray, with a pale olive-green lunate spot or patch on outer end of wing; the inside edge of this spot nearly straight, and outer edge evenly rounded and its lower half defined by cilia. Just beyond middle of wing is an irregular fascia, shaped much like outline map of South America, pale olive-green on inner and lower area, and replaced by velvety black on outer and upper area. A narrow fascia of olive-green crosses wing half way between central fascia and base, and between the narrow fascia and base are two abbreviated narrow fascia arising from dorsal margin and terminating at middle of wing; these bands are more or less overlaid with black scales. Five large, well-rounded, costal spots on outer half of wing, the outer one in the apex, and inner in central fascia; and there are several smaller, black, costal dots on inner half of the costa. The costa is very narrowly edged with white. Hind wing: very pale gray, a shade darker at apex. Expanse 12 to 13 mm.

Polychrosis viteana Clemens. Front wing: ground color, lilaceous or leaden-blue. The outer marginal patch is sharply indented above the anal angle by a spur of the ground color, the inner edge is less straight than *botrana* and bulges inward at middle of wing; the color is dark brown. The central fascia is more slender than *botrana,* its outer spur is sharply produced in some specimens turning upwards towards costa, and almost joining submarginal patch. The inner fascia is narrower than *botrana,* and the two short inner dorsal fasciae are only indicated by a few brown scales. Apical spot is larger than *botrana*, and there are three smaller, rectangular, oblique spots on costa beyond the central fascia. The inner spot, which in *botrana* is as distinctly defined as the other four, is in *viteana* not separable from central fascia. A few short streaks on costa before the middle. A shade of pale yellowish-brown, involves the outer half of costa between the central fascia and outer patch, giving the outer half of wing this color. Hind wing: smoky-brown becoming paler at base. Expanse 10 to 11.5 mm.

The many specimens bred by Professor Slingerland of the three broods on cultivated grape, and one or more broods on wild grape are remarkably uniform in coloration and maculation, and I have not observed a single specimen that varies sufficiently to form a connecting link between any two of the five species here treated.

Larva: 9 to 10 mm. cylindrical, rather robust, tapering from 4 to head and from 8 to anal segment. Pale, olivaceous green, with a reddish or purplish tinge from food within. Head flattened, slightly bilobed, luteous green on upper parts of lobes, discolored by brown in front. Mouth parts, and a horizontal dash on each side of lobe below middle, black. Prothoracic shield large, but narrow, luteous brown, bisected by pale green dorsal line. Thoracic feet black, green between the joints. Tubercular plates moderate, a slight shade darker than skin, shining. Anal plate not chitinous.

Polychrosis liriodendrana Kearfott.—(Trans. Am. Ent. Soc., Dec., 1904). Front wing: ground color, lilaceous or leaden-blue, much as *viteana*, but extending farther outward and involving a greater area of wing; the bands and spots in this species are nearly uniformly an ochreous olive-brown, a little paler around the edges, but with hardly a trace of black which is so characteristic of *viteana*. The outer patch is almost square, much smaller than the two preceding species. The outer spur of the central fascia is less produced than *viteana*, its upper limb is broader, and it is considerably broader on and above dorsal margin. The narrow fascia at inner third is more sharply angulated at middle than either *botrana* or *viteana*, and in some specimens is almost obsolete. Four large, rectangular, costal spots, beyond middle, the outer one in the apex. A narrow, oblique streak before the inner spot turns upward and merges into this spot. The ochreous-olive shade is most apparent on outer third of wing. Hind wing: darker smoky-brown than *viteana* and less pale at base. Expanse 11.5 to 12.5 mm.

Larva: 10 to 11 mm. cylindrical, less robust than *viteana*, slightly tapering, sordid green. Head yellowish-brown, ocellic field and lateral dash on lobes black. Mouth parts only slightly darker than head; prothoracic shield dark brown; thoracic legs black. Tubercular plates, concolorous, slightly shining. Anal shield not chitinous.

The larva makes a narrow tent along one side of the midrib beginning near the base on the under side of the leaves of *Liriodendron tulipifera*, sometimes tunnelling the midrib for a length of 15 to 20 mm. As it increases in size, the tent is widened, until at maturity a whole lobe of a leaf may be involved; rarely more than one on a single leaf. Spring or first brood not observed. Second brood, full-grown larvæ July 2 to 9; moths issued July 10 to 21. Third brood of larvæ from Sept. 15 to Oct. 15; hibernates as pupæ in the same form of cases as *viteana*.

Polychrosis slingerlandana Kearfott.—(Trans. Am. Ent. Soc., Dec., 1904.) Front wing: ground color, mottled shades of ochreous light-brown and dark-brown, the leaden-lilaceous blue is nearly obsolete, occurring only as a cilate band and a few scattered scales in basal third and streaks in outer third.

The patches and fasciæ of the preceding species are in *slingerlandana* very illy defined, and are much more clearly apparent in Fig. 24 than in the actual specimens owing to the absence of true color values in photographs. The outer patch is of rather triangular shape, nearly straight on inner edge and sharply indented above anal angle. The central fascia is nearly of corresponding shape. At the end of cell, below costa, is a flattened ovate patch of light brown and a spot of similar color on dorsum just before middle. The costal spots are not as clearly defined as in any of the preceding species, and are pale brown, each divided (geminated) by a short streak of black. Hind wing: very dark, smoky-black. Expanse 9.5 to 10.5 mm.

Larva on *Eupatorium perfoliatum;* 8 to 9 mm.: cylindrical, more robust than *viteana* or *liriodendrana*, slightly tapering, olive-green. Head, flattened, chestnut brown, mouth-parts darker brown, ocellic field, lateral dashes and thoracic feet dark brown. Prothoracic shield light chestnut-brown, darker shaded on posterior edge. Tubercular plates moderate, nearly concolorous, shining. Anal shield not chitinous.

First brood not observed. Second brood: larvæ, July 6 and 9 (Montclair, N. J.), in young flower-heads, tunnelling a passage, slightly silk lined. Moths issued Aug. 5 and 7. Third brood in mature flower-heads, tunnelling as before, and feeding on seeds and flowers, Sept. 7 to 20. Hibernates as pupæ, formed in cases cut out of a leaf same as in preceding species.

Polychrosis rhoifructana Kearfott.—(Trans. Am. Ent. Soc., Dec., 1904.) This species is nearest to *slingerlandana*, as it is much darker and more mottled than the first three species here treated, but its fasciæ and spots are much more sharply outlined. Front wing: outer patch, as in *slingerlandana*, merging into costal spot, but more flattened laterally and more rounded at apex. Central fascia with outer spur broader and more obtuse at its end. Between this central dark fascia and the dark narrow fascia at inner fourth, is a well defined pale brownish-gray fascia, slightly darker above than below the middle. The ground color of this species is more pronouncedly pale brown and whitish-gray than in any of the four preceding; with the darker olive-green and greenish-black spots and fasciæ well defined. A flattened, triangular patch of this ground color lays on the costa between middle and apex and contains the dark costal spots, of which the apical is rounded, the inner one rather large and rectangular, and the two intermediate smaller and triangular. Hind wing: pale gray, darker at apex and outer margin. Expanse 10.5 to 11.5 mm.

I have not bred this species. It has been bred in the insectary, Wooster, Ohio, from seed racemes of sumac; all of the specimens observed were forced, dates of emergence being Dec. 28 to Mar. 6. In the U. S. National Museum are some specimens that I refer to this species with considerable doubt; Prof. Riley's unpublished notes state that they were "Sumac leaf-rollers." The specimens look much like *viteana*, and I am inclined to think sumac and grape larvæ have been mixed, especially as the well-known Sumac leaf-roller is an entirely different species and genus of Tortricid, namely *Episimus argutanus* Clem.

NOTES ON THE RED-BANDED LEAF-ROLLER (*Eulia triferana* Walk.) THAT SOMETIMES WORKS WITH THE GRAPE-BERRY MOTH

While observing the work of the spring brood of the grape-berry moth caterpillars on the clusters of blossoms and recently-set fruits in June, a larger green caterpillar was quite often found at the same destructive work. The full-grown caterpillar is shown in Fig. 25. It is about the color of the small green grapes on which it works and has a slightly brownish head; the young caterpillars are light yellowish. The blossoms and young fruits are webbed together and fed upon by the caterpillars. When full-grown they spun a light cocoon between two leaves and in three or four days transformed to brown pupæ, from which the reddish-brown, banded adults or moths, shown in Fig. 25, emerged in ten days or on July 16 and 19. We saw nothing more of the insect in the grape-berries during the season, but it may work as a leaf-roller on the grape foliage. It is such a general feeder, that it probably will never become a serious vineyard pest.

This red-banded leaf-roller has been recorded as feeding on the following plants: cranberry, roses, clover, elm, soft maple, oak, apple, beans, strawberry, corn, *Gnaphalium polycephalum*, violets, chrysanthemum, Lobelia, honeysuckle, some other ornamental plants, and numerous field and garden crops. A moth in the National Museum Collection was bred from a caterpillar feeding on and boring into plums, which is not unlike its grape-berry eating habit. Mr. W. D. Kearfott has also reared the moths in August on narrow leaf Solidago and Dogsbane, and from over-wintered pupæ in May on Sycamore and Apple. Surely this is a variable diet even for an insect.

One of the parasitic foes of the grape-berry moth also attacks this red-banded leaf-roller. It is *Urogaster canarsiae* Ashm. We reared one specimen on July 12.

The arsenate of lead poison spray, which our experiments indicate is so effective against the spring brood of the grape-berry moth, will also reach its comrade—this red-banded leaf-roller.

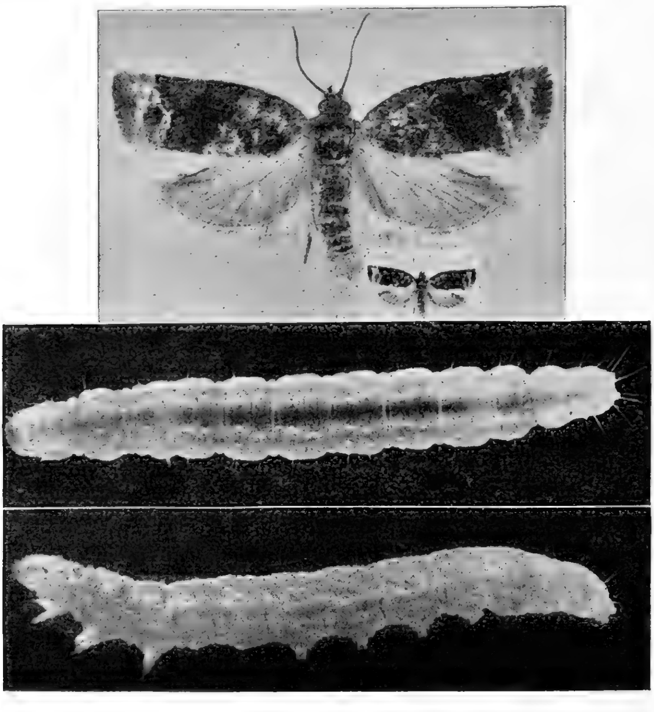

FIG. 25.—*The red-banded leaf-roller* (*Eulia triferana* Walk.) *and its caterpillar, enlarged.*

November, 1904 BULLETIN 224

CORNELL UNIVERSITY

AGRICULTURAL EXPERIMENT STATION OF THE COLLEGE OF AGRICULTURE

Department of Entomology (Extension Work)

TWO GRAPE PESTS

I. EFFECTIVE SPRAYING FOR THE GRAPE ROOT-WORM

II. A NEW GRAPE ENEMY: THE GRAPE BLOSSOM-BUD GNAT

By M. V. SLINGERLAND and FRED JOHNSON

ITHACA, N. Y.
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The regular bulletins of the Station are sent free to persons residing in New York State who request them.

College of Agriculture,
Cornell University, *November* 21, 1904.

Hon. C. A. Wieting,

Commissioner of Agriculture, Albany.

Sir.—About 150 different kinds of insects have been recorded as feeding on the grape-vine in this country; but not more than one-tenth of these now rank as serious or first-class insect pests, and only about one-half of the latter (or about half a dozen in all) have thus far done much injury in New York vineyards. This Experiment Station has made extensive studies of practically all of the serious insect pests of the grape-vine in New York, the only exception being that of the Rose-chafer, and upon this pest one season's preliminary observations and experiments have already been made. The previous results have been published in the following bulletins:

Bulletin 104, 1895. Climbing Cutworms in Western New York.
Bulletin 157, 1898. The Grape-vine Flea-Beetle.
Bulletins 184 and 208, 1900 and 1902. The Grape Root-worm.
Bulletin 215, 1904. The Grape Leaf-hopper.

When we have completed the studies of the Rose-chafer, this Experiment Station will then have made investigations of all the insect pests that have thus far appeared in very destructive numbers in New York vineyards.

L. H. Bailey,
Director.

FIG. 26.—A *horse-power vineyard sprayer.*

FIG. 27.—*A vineyard sprayer combining horse-power and compressed-air power. Note the effective, home-made screen to keep the spray from the driver.*

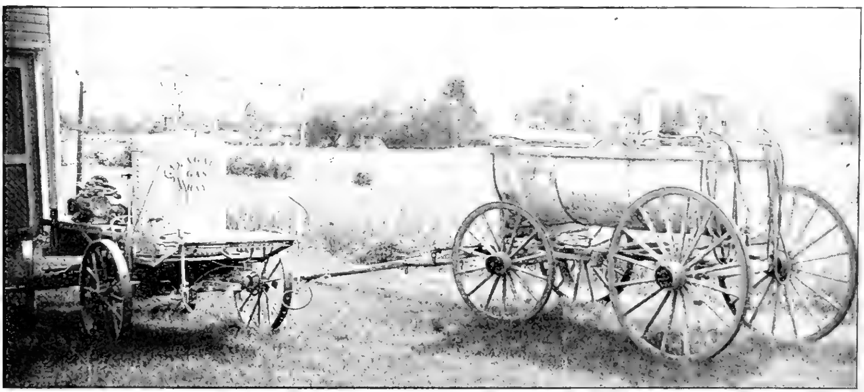

FIG. 28.—*A horizontal, hand-power outfit for vineyard spraying (on the right); and a vineyard sprayer using compressed carbonic-acid gas for power (on the left). Note how the nozzles are arranged for effective spraying on the gas-power machine.*

I. EFFECTIVE SPRAYING FOR THE GRAPE ROOT-WORM.

Fidia viticida Walsh.

The grape root-worm continues to be a serious factor in grape-growing in the famous Chautauqua grape belt, although its ravages were less noticeable and the vineyardists were usually not so much alarmed during the past year as in 1903. It is to be hoped that the insect's life-pendulum has begun its expected downward swing into obscurity as a pest, and there have been some indications to warrant such a hope in the infested region. Favorable growing conditions in 1904 have enabled many vineyards to make a very encouraging showing of vine and fruit in spite of the root-worm.

In 1903, this grape root-worm practically ruined some European varieties in a grapery at Glen Cove, Long Island. This isolated outbreak doubtless has no connection with the widespread Chautauqua infestation, but it is a hint that the insect is liable to become injurious at any time in other grape-growing sections of New York. The root-worm is the most destructive insect enemy of the grape in the State, and all vineyardists should acquaint themselves with its characteristics, habits and work.

During the past three years this Station has carried on extensive field experiments in Chautauqua county against the grape root-worm. Our discovery of the first appearance of this serious enemy of the vine in New York was announced in 1900 in Bulletin No. 184, and the results of a year's observations and extensive experiments were given in Bulletin No. 208, issued in December, 1902.

As the root-worm beetles eat the foliage of the grape in considerable quantities and feed openly on the upper sides of the leaves for two weeks or more, theoretically, it should be an easy matter to feed them poison with a spray pump. In 1902, we made extensive experiments on about 15 acres of vineyards with an arsenate of lead spray, the details of which are given in Bulletin No. 208, pages 189–191. The abnormal rainy season then interfered so much with our experiments that it was impossible to draw any definite conclusions either way. Although discouraged, we were not convinced of the futility of a poison spray as an effective method of fighting this insect.

Experiments in 1903.—In 1903, Mr. John W. Spencer co-operated with us in making a further test of a poison spray for the beetles working on the leaves. As a criterion for determining the results of spraying, we counted the egg-clusters laid on the vines. As all of the eggs are always laid under the loose bark on the vines, their presence or absence is a much better and surer test of the number of grubs that may later attack the vine than to dig around the roots and count the grubs one may chance to find in the soil. In July Mr. Spencer reported (*The Grape Belt*, July 24, 1903) the following results from spraying with arsenate of lead at the rate of 4 pounds in 50 gallons of water: *Plot No.* 1 was not sprayed; the foliage was much eaten by the beetles; and 97 egg-clusters were found on 10 vines. *Plot No.* 2 was sprayed once thoroughly about the time the beetles emerged from the soil; there was but little feeding on the leaves; and only seven egg-clusters were found on 10 vines. *Plot No.* 3 was sprayed thoroughly about the time the beetles emerged and again about eight days later; there were scarcely any of the characteristic "markings" of the beetles on the leaves; and only one egg-cluster was found on 10 vines. The egg-clusters on the sprayed vines averaged only about 15 eggs each, while those on the unsprayed vines averaged twice as many. This work was done in the most thorough and accurate manner by the junior author, Mr. Johnson. These striking results whereby more than 95 per cent of the eggs were apparently prevented from being laid, were certainly very encouraging. It should be said, however, that there were contrary opinions in regard to the efficacy of this spraying (Bulletin 72, N. Y. State Museum, p. 41. *Rural New Yorker*, June 4, 1904, p. 449). However, another reliable vineyardist also sprayed a large part of his vines but once with the arsenate of lead, and he felt very sure that he accomplished much toward controlling this destructive pest; and a superficial examination of his vines in comparison with a neighbor's gave very encouraging results.*

These encouraging results led many of the vineyardists in the infested region to arrange to spray in 1904.

Experiments in 1904.—This Station also determined to get conclusive evidence, if possible, one way or the other in 1904. Fortunately, a large vineyard was placed at our disposal into which a swarm of the beetles had migrated and fed extensively from a badly infested vineyard across a meadow 30 or 40 rods away the preceding summer. This migration of the beetles in a body from one vineyard into another thrifty one, affording better pasturage for themselves

*Others who examined this vineyard for the grubs in October reported that "the good results were more apparent than real," but the owner, who was prevented by serious illness from showing the sprayed and unsprayed portions, tells us that the wrong vines were examined.

and their grubs later, is a new and very alarming fact. For it means that the best-cared-for vineyards are constantly menaced by neighboring infested vineyards where no fight is being made against the pest.

Many of the grubs were found on the roots of the vines in our experimental vineyard in the fall of 1903, and the next June 15 pupæ were hoed out from beneath some vines. Thus the vineyard was well infested by the insect, and as the vines were very thrifty and in heavy foliage during the season, the conditions were ideal and seemed to meet the objections made against our previous year's work.

The first root-worm beetle was seen in the experimental vineyard on June 23, and spraying was begun two days later, or on nearly the same date as in 1903. Six rows of vines through the center were left unsprayed for a check experiment, and the remainder of the vineyard on one side the check rows was sprayed with arsenate of lead, and on the other side this poison was used with Bordeaux mixture. Four pounds of the poison was used in fifty gallons of water or Bordeaux mixture. The first spraying was finished on July 2, and on July 11 and 12 the vines were again sprayed with the same mixtures. The work was thoroughly done by the junior author, who is an expert in this kind of work. Part of the first spraying was done with a hand-power, horizontal pump on a large tank (Fig. 28), and the remainder of the work was done with a carbonic-acid gas sprayer (Fig. 28), which thoroughly sprayed in one day seven and one-quarter acres. The total cost of the first spraying on eight and one-quarter acres was $39.10, and 1,500 gallons of poison was used. The second application cost only $23.15 to apply 1,000 gallons of poison. This difference in cost was due to the more rapid but equally as thorough work with the carbonic-acid gas-power machine that required the services of but two men, one to drive and one to attend the fixed nozzles. The gas-power pump with its higher pressure gave a finer spray, and thus used less of the poisonous mixture in the second spraying. With proper apparatus, vineyards can be sprayed thoroughly and effectively for the root-worm beetles at the rate of six to eight acres a day for not over $3 an acre for each application.

Results of spraying experiments in 1904.—Soon after the second application of poison on the experimental vineyard, it was very evident that the foliage on the sprayed vines was being much less eaten by the beetles than on the check rows. On July 21, the junior author applied our decisive test by counting the egg masses on 15 vines in the sprayed sections each side of the check rows, and then on 15 unsprayed vines, with the following results:

One hundred and fifty-one egg-clusters were found on 15 unsprayed vines.

Eleven egg-clusters were found on 15 vines sprayed twice with arsenate of lead.

Seven egg-clusters were found on 15 vines sprayed twice with the poison in Bordeaux mixture.

These results are equally as striking as those we obtained in 1903. Instead of an average of over 10 egg-clusters of the root-worm beetles on each vine, the poison spray reduced the number to about one-half an egg-cluster to a vine. And furthermore, it was also noted that the egg-clusters on the sprayed vines were only about one-half as large as those on the untreated vines; the average number in each cluster on the former was about 15 and on the latter over 30, thus further corroborating the previous season's work. Where no eggs are laid there surely can be no grubs to eat the roots and kill the vines. It is rarely that such remarkably favorable results are obtained with insecticides in experiments against any injurious insect. We believe *our results are decisive and conclusive, and we consider it demonstrated that the grape root-worm can be effectively fought and controlled with a poison spray.*

In all of our experiments against the root-worm, we have used the arsenate of lead or "Disparene" poison, because it sticks well and can be used much stronger than the other poisons without danger of injuring the vines. However, it is probable that very effective work can be done against the beetles with Paris green (1 lb. in 50 gals.) or arsenite of soda or lime (1 lb. of the white arsenic in 100 gals.) when used with Bordeaux mixture; if used alone in water these poisons might burn the foliage severely. We recommend the use of four pounds of the arsenate of lead or "Disparene" in 50 gallons of water or Bordeaux mixture. Make two very thorough applications of this poison, the first as soon as the first beetles are seen in the vineyard, or about June 20 to 25, and the second a week or 10 days later. These applications will reach the grape berry-moth (as described in Bulletin 223), and if Bordeaux mixture is used, the fungous diseases also will be checked. For the root-worm beetles the spray should be aimed at the upper surfaces of the leaves, for there is where the beetles feed, and the more thoroughly every leaf is covered with a fog-like spray of poison, the more effective it will be. *We doubt if the grape root-worm can be so cheaply and effectively fought and controlled by any other method.*

In further confirmation of the above conclusions, it is a pleasure to quote the following from a letter received last August from a prominent vineyardist in the infested region:

"You cannot doubt my great gratification in reporting a decisive and complete victory as the result of this year's fight against the root-worm. I sprayed the larger part of my vineyards twice with 'Disparene,' and where this was done a critical examination revealed scarcely any eggs and the foliage is almost wholly free from the marks of the beetles; while in unsprayed vineyards nearby, eggs were very abundant, the foliage is badly marked, and all the indications of a serious infestation are present. From such results there can be but one conclusion, namely, that timely and thorough spraying with 'Disparene' or arsenate of lead affords absolute protection to vineyards from the grape root-worm and restores the grape industry to its former position as a safe and profitable business."

A. A. Skinner

Does the spray kill the root-worm beetles? We think it does kill many of them, and it may also act as a preventive. In a day or two after the poison had been applied, we found quite a number of dead beetles on the ground beneath the vines, and some were seen to drop to the ground and die. As the beetles are small and resemble a bit of soil, and as ants soon find and destroy them, it is not an easy matter to find the dead ones on the ground. A few of these were submitted to our chemist to test for arsenic, but none was found, indicating that they may not have been poisoned.* It is not improbable that some of the beetles may shun the poisoned foliage and go to more attractive unsprayed vineyards. But it matters little to the vineyardist whether the beetles are killed or driven away, so long as they are prevented from laying eggs on his vines and a crop of destructive grubs thus prevented from eating the roots.

Notes on other methods.—Great claims were made in 1903 for the effectiveness and practicability of various devices for catching the

*Several of these dead beetles were kept in a tightly corked bottle for ten days, when a lot of small maggots crawled out of them. Thinking that these maggots might be parasitic enemies of the root-worm beetles, we put some soil in the bottle and in this the maggots transformed into a small fly known as *Aphiochaeta fungicola* Coq. This fly was first bred from a tree fungus (Can. Ent. XXVII, p. 105). It is doubtless a carrion-feeder and thus works only on the dead root-worm beetles.

root-worm beetles when they were jarred from the vines. Several vineyardists bought Morehouse "beetle-catchers" and planned to use them in 1904. Some did use them for a while, but soon discarded them for the poison spray. A prominent vineyardist who invested $45 in one of these machines gives us the following report of his experience: "My experience with the beetle-catcher was rather disappointing. The jarring of the vines took off some of the fruit, and the machine did harm to the vines by tearing off some of the canes and coming in forcible collision with the trunks, even when the latter were straight. Though I think a lighter machine might do less harm and be more successful, I shall rely hereafter wholly upon spraying."

By June 20 most of the root-worms were found to have transformed to the tender pupa or "turtle" stage in our experimental vineyard and horse-hoeing was begun at once. But we were surprised to find that very few pupæ were turned out either by the horse-hoe or by hand-hoeing to the usual depth of cultivation. On working deeper, however, many pupæ were found. A possible explanation may be that the unusually severe winter conditions drove the grubs more deeply into the soil. Under normal conditions, we still believe that much can be done to check this insect by thorough cultivation during the last ten days of June, when it is in the tender pupa stage.

Notes on Practical Vineyard Spraying.

Sooner or later, in all grape-growing sections, the time comes when insect pests or fungous diseases invade the vineyards and the crop is ruined unless a vigorous warfare is carried on against such enemies. A good spray pump is the most useful and effective implement in this warfare. For many years the famous Chautauqua vineyards were practically free from fungous and insect troubles, and no spray pumps were needed. But during the past few years such insect foes as root-worms, leaf-hoppers, berry-moths and flea-beetles have ravaged many of the vineyards, and now rot, mildew, and anthracnose fungi are on the increase. The time has come when every vineyardist should be prepared to spray a deadly dose into the menu of these serious menaces to his business.

The fungous rots and mildews usually succumb to a thorough and timely application of Bordeaux mixture, as many vineyardists can testify. And this Station has demonstrated that the root-worm beetles (in this Bulletin), the berry-moths (Bulletin No. 223) and flea-beetles (Bulletin 157) can be controlled with a poison spray;

and we conquered the leaf-hoppers with a whale-oil soap spray (Bulletin No. 215). Therefore, a vineyardist's ammunition should consist primarily of Bordeaux mixture and some poison, preferably arsenate of lead or "Disparene;" to this add whale-oil soap for leaf-hopper emergencies. Anyone can easily make this ammunition and the ingredients are cheap and readily obtained. Our spray Calendar Bulletin No. 217 gives detailed information for preparing the mixtures.

During the past season several vineyardists used a ground or "New Process" lime in making Bordeaux mixture. Two samples of these prepared limes were submitted to our chemist, who reports that both were made from dolomitic limestone, and one contained over 35 per cent and the other over 48 per cent of magnesia and other matter that were non-available or practically useless for combining with the copper sulphate in making Bordeaux mixture. It is undoubtedly easier and handier to use these "New Process" limes than the common stone lime, but it requires from one-third to one-half more of them to satisfy the chemical combinations required in making good Bordeaux mixture. Unless the ferro-cyanide test is used in making the Bordeaux mixture, there is danger of not getting in enough of the kind of lime necessary to neutralize the copper sulphate, and burning of the foliage may result. Thus it is doubtful if it pays in the end to load up the spray mixture with so much useless powder.

After getting his ammunition ready, the vineyardist is confronted with the more serious and difficult problem of its proper, effective and practical application. For the cheapest and most practical spraying of large vineyards, it is necessary to have a pump run by some stronger and cheaper power than hand power, and there should be a suitable arrangement of several adjustable nozzles. When the gun is properly loaded, one or two persons should be able to drive it between the rows of vines and fire a continuous volley of effective and well-directed shots on each side at the enemies as fast as the horses walk. Some of the spraying rigs used in the Chautauqua vineyards last season are shown in Figs. 26, 27 and 28. The best arrangement of nozzles we have seen for thorough spraying in vineyards is on the gas-power pump in Fig. 28. For the most effective work it needs three or four nozzles on each side, and for the root-worm beetles one of them should spray downward onto the top of the vines. Have the nozzle connections adjustable so they may be easily arranged to suit vines of different ages and heights.

A very fine, misty or fog-like and forceful spray is necessary for the most effective work, and to obtain and continue this through six or eight nozzles, it is necessary to have a continuous pressure of from 80 to 100 pounds. All spray pumps should have a pressure gauge attached. It is too laborious and expensive to maintain this pressure by hand-power in large vineyards. But it can be done cheaply and practicably by horse-power aided by compressed air, by compressed air alone, by compressed carbonic-acid gas, and by steam or gas engines. There are now various types of such power spraying machines on the market, but they need further adapting and strengthening for vineyard work. Horse-power alone does not seem to work up sufficient continuous pressure for six or eight nozzles. Perhaps the cheapest and most available way of obtaining a satisfactory pressure is by attaching to a horse-power machine an air-tank in which air is being continuously compressed as the horses move. A strong and durable machine, thus combining horse-power and compressed air, which will supply a continuous pressure of 80 to 100 pounds to six or eight fixed nozzles properly arranged would enable vineyardists to effectively fight their insect and fungous enemies at a minimum of expense for power.

The apparatus for using compressed air, or steam, or gasoline power is rather expensive, but with good pumps and properly arranged nozzles, very effective and satisfactory work can be done cheaply and quickly. The tanks of compressed carbonic-acid afford a neat, compact and very efficient power; but they are somewhat expensive and obtainable only in large cities.

II. A NEW GRAPE ENEMY: THE GRAPE BLOSSOM-BUD GNAT.

FAMILY *Cecidomyiidae*.

Vineyardists often find after blossoming time that there has been a poor "setting of the fruit" on many of the grape clusters, and the clusters present a ragged appearance throughout the season. Usually this is attributed to unfavorable weather conditions, either frost or rains, which kill the blossoms or prevent proper fertilization. Doubtless these causes are often responsible for the ragged clusters of fruit, but we have discovered another cause which sometimes may have more to do with it than weather conditions.

The discovery.—On June 12, 1904, when the blossom-buds of the grape clusters were about two-thirds developed in a Westfield vineyard, the attention of the junior author was attracted by some of the buds that were about twice as large as the normal ones, and of a yellowish or dark reddish color, with a watery and swollen appearance.

An examination of these abnormal buds showed that they were inhabited by many minute maggots; sometimes as many as 18 were found in a single grape blossom-bud, as shown in the enlarged pictures of opened buds in Fig. 29. It seems almost incredible that so many maggots could find sustenance in such a small home. Infested and normal blossom-buds are shown enlarged in Fig. 29. The maggots seemed to feed mostly on the pistil of the developing blossom, causing an unusual development or gall-like growth of the rest of the blossom-bud.

The nature of this new grape enemy.—We have never seen, and have little hope of soon breeding, the adult insect which laid the eggs from which these blossom-bud maggots hatched. The little maggot shown in the lower part of Fig. 29, measures from 2.2 to 2.4 mm., or about 1-16 of an inch in length, and is of a whitish color while in the buds, but changes to a light lemon-yellow when it is ready to transform. This is the only stage of the insect we have seen, but the fact that these maggots possess a minute, forked organ, called by entomologists a "breast-bone" (visible near one end of the maggot in Fig. 29), indicates that the adult is one of the little two-winged flies known as "gall-gnats." Among its nearest insect relatives are the clover-seed midge, the Hessian fly, and the wheat midge, all serious pests of field crops. When the minute grape-blossom-bud gnat is found, as it is doubtless a new species, we would suggest it be given the specific name of *johnsoni* in honor of the junior author who first observed its work. The flies should be sought for during the latter part of May on the clusters of blossom-buds in vineyards.

We have searched the literature, both American and European, and find no record or description of such an insect working in grape blossom-buds; and there is nothing about it in the records of the Bureau of Entomology at Washington, reports Dr. Howard. Several of these gall-gnats live in galls in grape leaves in America and Europe, and one has been found in the grape-berries in Europe. We seem to have discovered, not only a new grape enemy, but a species of insect hitherto unknown.

Its distribution and destructiveness.—This new grape enemy was found last June in nearly every vineyard in the towns of Ripley, Westfield, Portland and Brocton in Chautauqua county. It was always more abundant in neglected vineyards and those near wood-lots or hedge-rows. We suspect that the insect is not uncommon in many of the other grape-growing regions of the country.

Many of the clusters in infested vineyards contained a dozen or more of the abnormal blossom-buds, and in one vineyard nearly a third of the buds were destroyed on many clusters. Thus the insect is capable of making very ragged bunches of grapes, for all infested blossom-buds soon appear blackened and blasted and fall from the clusters.

The life-history and habits of the insect.—We have but little definite knowledge of the life-history of this grape blossom-bud gnat. Probably the minute, two-winged gnats emerge from the soil in May and lay their eggs on, or possibly stick them into, the growing blossom-buds of the grape clusters. Hatching in a few days, the little maggots live inside the blossom-buds, feeding on the pistil and causing the buds to enlarge and take on a reddish color. Developing rapidly, the maggots get full grown and are ready to leave before the blossoms open. They emerge from the buds either by eating holes in the sides, or through slits caused by the breaking of the bud-cap in an attempt to open into the blossom. Dropping to the ground, the maggots soon bury themselves. We have found as many as 18 maggots in a single grape blossom-bud. None of the infested buds ever open into blossoms, but soon shrivel and blacken or "blast" and drop off after the maggots leave them. The maggots wriggle about actively, and often bring the two ends of their body together, and by suddenly straightening out, throw themselves nearly half an inch into the air and about that distance over the ground.

By June 23 all the maggots had gone into the ground and their further life-history is still one of Nature's many mysteries. Possibly they may transform into another brood of the gnats whose maggots make galls on the grape foliage or live on some different plant; or the insect may remain in the soil as maggots or pupæ until the next May. We saw nothing more of the insect after the maggots went into the soil late in June, and were unable to keep the maggots alive in our cages.

Remedial suggestions.—Apparently there is no practicable way to get at this new grape enemy with a spray of any kind. It is out of reach inside the little blossom-buds. But the fact that we found it occurring in injurious numbers only in neglected vineyards or near wood-lots or hedges, indicates that the progressive grape-grower who properly cultivates and feeds his vines can always keep this new insect under control.

MARK VERNON SLINGERLAND.
FRED JOHNSON.

Fig. 29.—*The grape-blossom-bud gnat and its work (enlarged). Compare the normal blossom-buds with the larger and darker buds. Two infested buds are more enlarged and opened to show the maggots at work. One of the maggots is shown much enlarged in lower part of the figure.*

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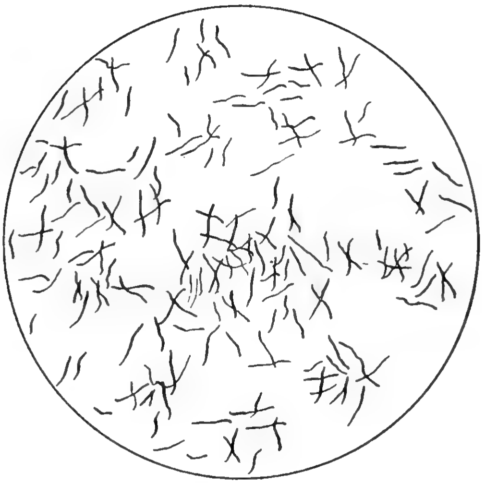
February, 1905 BULLETIN 225

CORNELL UNIVERSITY

AGRICULTURAL EXPERIMENT STATION OF THE COLLEGE OF AGRICULTURE

Veterinary College (Extension Work)

BOVINE TUBERCULOSIS



Tubercle bacilli magnified more than 2000 diameters.

By V. A. MOORE.

ITHACA, N. Y.
PUBLISHED BY THE UNIVERSITY

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Of the Cornell University Agricultural Experiment Station.

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The regular bulletins of the Station are sent free to persons residing in New York State who request them.

College of Agriculture, Cornell University,

Ithaca, N. Y., *February* 1, 1905.

Hon. C. A. Wieting, *Commissioner of Agriculture:*

Sir.—The stock-growing interests of New York State are so large and there is such a growing interest in tuberculosis of cattle, that it seems best to issue a plain and popular account of the disease for the general information of the public. This account is prepared by Dr. V. A. Moore, of the New York State Veterinary College, one of the best American authorities on the disease.

The twelfth census of the United States gives the following figures of the number of neat cattle in New York State, June 1, 1900, "on farms and ranges and in barns and inclosures elsewhere":

Calves under one year	513,103
Steers one year and over	77,003
Heifers one year and under two years	338,980
Bulls one year and over	85,657
Dairy cows two years and over	1,537,921
Other cows two years and over	99,280
Total	2,651,944

Respectfully submitted,

L. H. Bailey,

Director College of Agriculture.

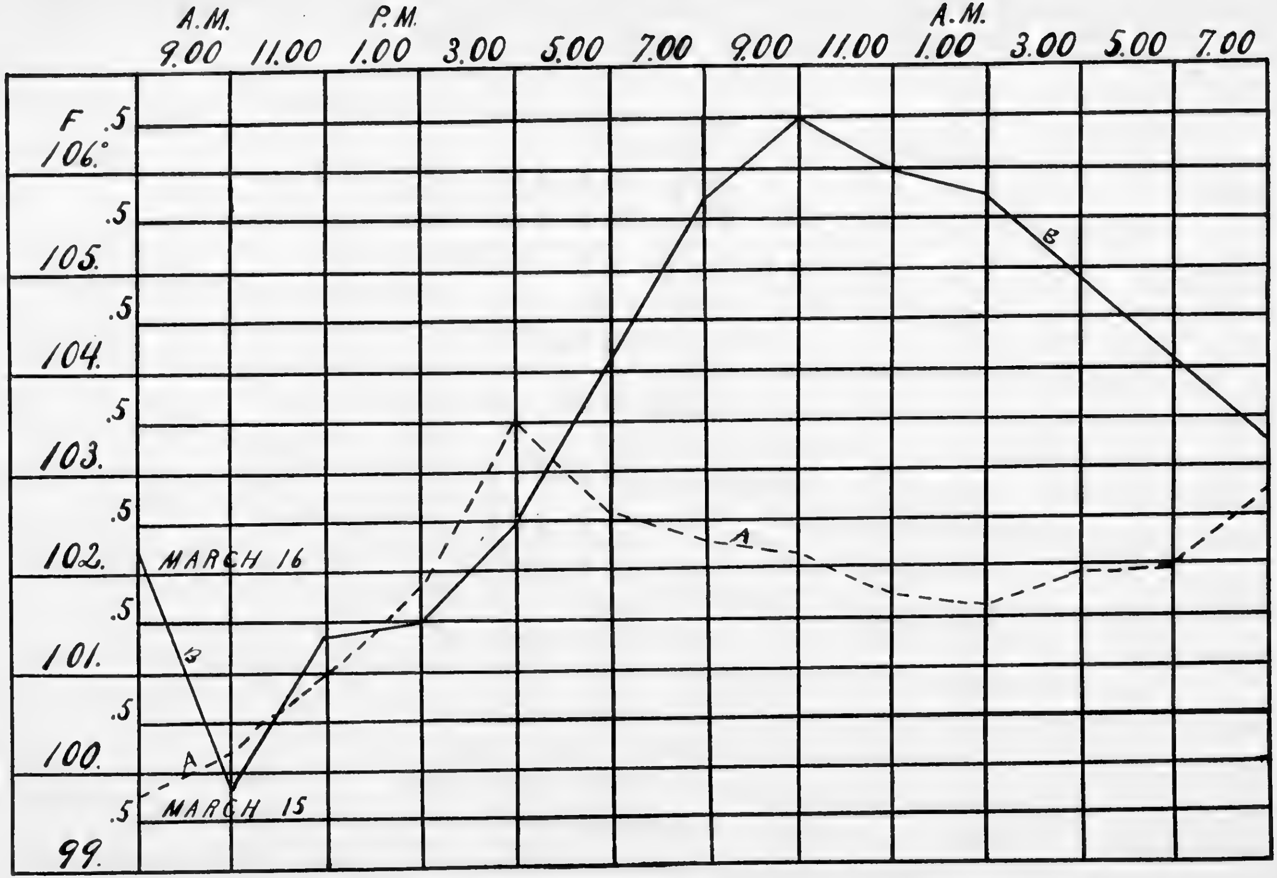

FIG. 30.—Temperature curves. *The dotted line "A" represents the temperature of a cow for 24 hours before injection of tuberculin. The solid line "B" represents the temperature for 24 hours after the injection of tuberculin, showing the tuberculin reaction between 4 P. M. and 7 A. M.*

BOVINE TUBERCULOSIS.

Bovine tuberculosis is one of the oldest diseases of animals of which we have knowledge. It was known to the Egyptians in the days of their captivity, and from then until now it has been a subject of much thought and investigation. The opinions that have been entertained concerning it have been changeable, the decrees of one century as to its supposed infectious nature and the use of the flesh of the infected animals often being reversed by those of the following century. History shows that up to the time of the introduction of modern scientific methods for the study of disease, there was little that was definite in our knowledge of tuberculosis beyond the fact that it was a very destructive disease of both men and cattle.

In 1865, tuberculosis was demonstrated to be infectious. In that year Villemin showed that it could be produced in healthy animals by inoculating them with pieces of tuberculous tissue. His results were confirmed by a number of other investigators. In 1882, Robert Koch discovered the bacillus* (or micro-organism) of tuberculosis and thus completed the already abundant evidence that tuberculosis was a specific, infectious disease. The finding of its specific cause led to many careful and extended investigations into the nature of tuberculosis, the means by which it is spread, and the measures that must be adopted if its spread is to be checked. The results of these numerous inquiries have given us very definite knowledge of the nature of the disease. It is believed that this knowledge, if properly used, will enable every cattle owner to eliminate tuberculosis from his herd if it is there, and to keep it out if it is not there.

In order to have a clear understanding of what kind of a disease tuberculosis is, it may be well to compare it with some disease that is generally known and recognized to be infectious. For this we may take diphtheria in children. It is well known that diphtheria is caused by a micro-organism. This organism is known as *Bacillus diphtheriæ*, or sometimes as the Klebs-Loeffler bacillus, from its dis-

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**Bacteria* (singular *bacterium*) is a general name for "germs" of a vegetable or plant nature. A *bacillus* (plural *bacilli*) is one kind of bacteria, distinguished by being much longer than broad. A *micrococcus* is a spherical bacterium. General terms used to designate many of these minute forms of life are "microbe" and "micro-organism."

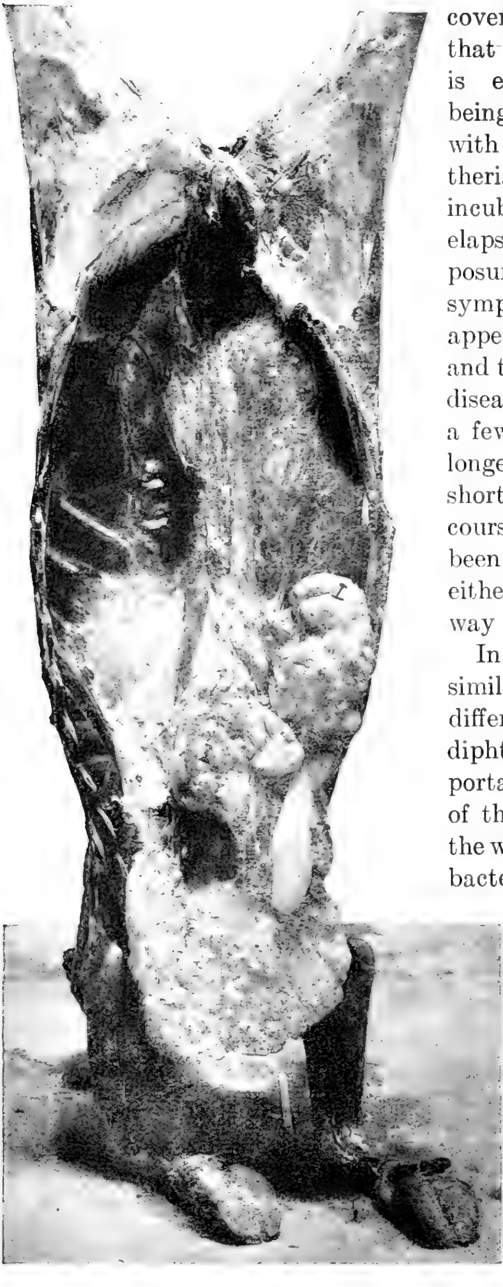

FIG. 31.—*The carcass of an animal killed for beef showing tuberculosis of the liver, omentum and lungs. Generalized tuberculosis.*

coverers. It is also known that when a healthy child is exposed (infected) by being brought in contact with a child sick with diphtheria, that the period of incubation (that is, the time elapsing between the exposure and the time the symptoms of the disease appear), is but a few days, and that the duration of the disease is short, lasting but a few days or weeks at the longest. At the end of this short period, the entire course of the disease has been run and the child is either dead or well on the way to recovery.

In tuberculosis we have similar conditions, but they differ in detail from those in diphtheria in three very important points,—the length of the period of incubation, the way in which the specific bacteria produce the disease, and the time required for the disease to run its course. With diphtheria the specific bacteria produce a toxine which poisons the system, and this toxine is the cause of death. In tuberculosis the specific bacteria do not produce such a toxine, but they live in one or more of the tissues of the body, multiply there, and by their increase penetrate deeper and deeper into the organs of the body, destroying the tissues as they go. Finally the injured organs give rise to symptoms, at first slight, but gradually they become more and more serious until death is produced, because some organ necessary for the life of the individual has been destroyed. While diphtheria completes its course in a few days or weeks, tuberculosis requires for the same purpose months and more often years.

It is important that both the specific, and the infectious nature of tuberculosis be understood. It is a "specific" disease because it is produced by a *single* cause—the tubercle bacillus. It is "infectious" because the tubercle bacteria are taken into the body. This may be by direct contact or by the bacilli being left in a manger, or watering-trough, or elsewhere by a diseased individual and later, but before they die, being taken up by a well animal. Thus a barn containing tuberculous cattle will become infected, and healthy animals placed in such a barn before it is disinfected are very liable to contract the disease. It is often said, that badly ventilated and poorly kept barns, and improper food cause tuberculosis. This is not the case. The disease cannot develop in the absence of the tubercle bacillus, any more than corn can grow in a field in which no corn has been planted. It is, however, undoubtedly true, that in poorly ventilated, dirty barns, the tubercle bacilli may be distributed more rapidly than in sanitary stables, but poor air and filth cannot of themselves produce tuberculosis.

In considering, from a practical point of view, an infectious disease like tuberculosis, we must take into account seven important features: (1) the *cause,* (2) the *method of infection,* (3) the *period of incubation,* (4) the *duration of the disease,* (5) the *way to detect or diagnose it,* (6) the *way to eliminate it,* and (7) the *methods for preventing it.*

1. Cause of Tuberculosis.

Tuberculosis is caused by a micro-organism, the bacillus of tuberculosis. It is a very small rod-shaped micro-organism. It is so minute that 10,000 of them might be placed end to end within the linear distance of a single inch. This organism has a peculiar way of retaining the stain used for coloring it, so that it is possible to distinguish it from other bacteria by a microscopic examination. It will kill guinea pigs when a very few of the bacilli are injected into the subcutaneous tissue. It is also fatal to other animals. The tubercle bacilli that are found in tuberculous cattle and people often differ very slightly from each other, but it is known that they belong to the same species. The Royal Commission on tuberculosis, appointed by the King of England in 1901, has recently made a partial report in which they state that they have been unable to find any difference in the disease-producing power of the bacilli from human and from bovine sources.

This bacillus seems to be able to live for some time in dark and damp places. It is readily killed with a five per cent solution of carbolic acid, or a 1 to 1,000 solution of corrosive sublimate. Sunlight and dry air are not favorable for its existence outside of the body.

The tubercle bacilli escape from the diseased animal in the saliva and mucus from the mouth when the lungs or certain glands are discharging into the *respiratory tract.* They escape in the pus from tubercular abscesses that open through the skin, and in the milk. Dr. Salmon has recently stated that all of the examinations that have been reported of milk from tuberculous cows show that about 15 per cent of them give off tubercle bacilli with their milk at some time during the course of the disease. The udders show tuberculosis in about two per cent of the cases.

FIG. 32.—*A drawing of a heart of a steer that was killed for beef. The heart muscle is entirely surrounded by a dense mass of tubercular deposit. There were no other lesions found in the animal.*

2. THE METHOD OF INFECTION.

Animals become infected with tubercle bacilli largely through the digestive tract. The infection by means of inhaling particles of dirt or dust carrying tubercle bacilli, or by getting them into wounds of the skin, is possible but certainly not very common. Healthy cattle "nosing" with infected ones or feeding and drinking after them is supposed to be the most usual method of infection. The infection of calves by feeding them milk from tuberculous cows is not an infrequent means of propagating the disease. The slow development of the disease makes it possible for calves to be infected and frequently they do not show evidence of tuberculosis for many years. I have known of a very large percentage of calves fed upon milk of diseased animals to give a good tuberculin reaction (thus showing the disease) before they were six months old. This is believed by the writer to be one of the very important ways by which the disease is disseminated in breeding herds.

Tuberculosis is often found in swine fed upon milk from infected cows. In 1903 the writer knew of a carload of hogs that had been purchased in a district where there were many tuberculous cows, and of which the first 59 of them that were slaughtered were all tuberculous. The remainder were not killed at that time. While such a condition may be considered an exception, it is a fact that many swine are infected, especially when they are fed tuberculous milk.

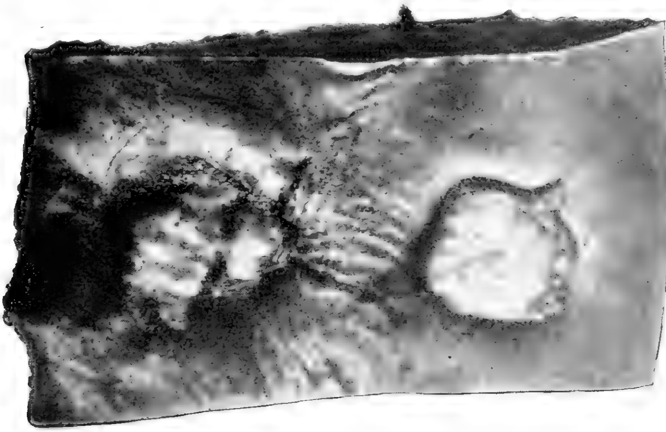

FIG 33.—*Liver of a cow showing two small tubercular deposits. They were the only lesions found. The cow gave a typical tuberculin reaction. Natural size.*

Last year the United States meat inspectors condemned about 20,000 hogs for tuberculosis.

It should be remembered that the greater the percentage of tuberculous cows in the herd, and the further advanced the disease is in the cattle, the greater the danger of infection from the use of the milk. In cases where the disease is restricted to small nodules in the lymphatic glands, or perhaps in the lungs, the danger of tubercle bacilli being in the milk is very slight, but when the udder is tuberculous they are constantly present in the milk and often in very large numbers. When calves or pigs are fed with milk of this kind, they are almost sure to be infected. The same result may follow when it is fed to children or adults.

Practically the only way tuberculosis gets into a herd of healthy cattle is by the introduction of a tuberculous animal. It has often happened that farmers who have perfectly healthy cows, buy a nice looking cow that is tuberculous, although the disease was not at all in evidence, and sooner or later this animal infects a very large number of animals in the herd. *The buying of infected animals is largely responsible for the spread of tuberculosis in cattle.*

The history of tuberculosis in cattle shows that when it is once introduced into a previously uninfected district its tendency is to spread from farm to farm with a rapidity which depends largely

FIG. 34.—*Tuberculous ulcers in the intestines of a tuberculous cow. These are not common in cattle.*

upon the activity of the cattle traffic. If the interchange of animals between herds is frequent the disease usually spreads rapidly. If, on the contrary, there is but little interchange of animals, tuberculosis spreads slowly in the newly infected community. This observation relates to the spread among herds; other conditions govern the spread of tuberculosis after infected animals are added. The latter factor is controlled by the degree of contact between the diseased animals and their associates, and the sanitary and other conditions to which the herd is subjected. The extent of cattle traffic is one reason why there is greater danger from tuberculosis now than there was a generation ago.

If a tuberculous cow is placed in confinement with other cattle she will convey the disease to them more certainly and more quickly than when the animals are at liberty. As bearing upon this point, it has been noted repeatedly that tuberculosis spreads more rapidly in herds when they are confined in winter than when they are at pasture in summer, and there is reason to believe that this difference is due, not to the season, but to the intimacy of contact. Moreover, tuberculosis once introduced, spreads with increasing rapidity as the centers of infection are multiplied. So long as there is but one infected herd from which it may spread in a district, the extending of the disease will necessarily be slow, but when 10 herds are infected from this one the progress of the disease will be 10 times as rapid, and when five herds are infected from each of the 10, the disease will, other factors being equal, spread at 50 times the original rate of progress.

3. The Period of Incubation.

In case of many of the infectious diseases, the time that elapses between the exposure (infection) of the individual and the time when the disease appears is short and more or less uniform. This makes it possible to quarantine suspected animals until after this period has passed and thus ensure safety in placing them with the home stock. With tuberculosis this period is not regular and it is not known how long it may be. Our present knowledge of the subject shows that it varies from a few days to as many months. *Tuberculin* (see page 89) *does not give a reaction during this period.* It is necessary, therefore, for safety that cattle that do not react when purchased should be tested again in from three to six months later, as it is possible they were bought after they had become infected but in the period of incubation. This precaution is of great importance in protecting a dairy. The newly purchased cows should be kept apart from the herd until after the second test.

4. The Duration of the Disease.

Tuberculosis is a disease of very slow progress. It often requires years for it to destroy its victim. The tubercle bacilli multiply and penetrate into the organ in which they were first carried and gradually destroy it. It often happens that the tubercle germs pass into the blood or lymph and are carried to other parts of the body where each germ starts a new tubercle. This is the condition known as generalized tuberculosis, "miliary tuberculosis" or "quick consumption." Fig. 31.

When the diseased tissues are restricted to one organ, the condition is known as local tuberculosis. Fig. 32. When the organs in two of the cavities, such as the lungs, in the pleural cavity, and the liver in the abdominal cavity, are affected the condition is known as generalized tuberculosis. This is very important, as the meat inspection regulations of this and other countries permit the flesh of animals suffering from local tuberculosis to be used for food.*

When the disease is local, it often requires a very long time for it to invade the organs sufficiently to cause the death of the animal. It may happen that the germs of the disease are lodged in some organ, like a lymphatic gland, that is not absolutely necessary for the life of the animal, and the entire organ may be destroyed without apparent injury to the individual. If the diseased process is arrested before it has advanced too far, even when it is in a vital organ, such as a lung, the liver, or the kidney, the animal will continue to appear to be perfectly sound. Animals thus affected are thought to be perfectly well, as they appear to be, but sooner or later the disease starts

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*Following are the United States regulations concerning the use of flesh of tuberculous animals:

"Generalized" tuberculosis refers to that form of the disease in which the bacilli have been disseminated through the blood and lymph, and in which a number of organs are affected. "Extensive" tuberculosis refers entirely to the amount of tuberculous matter and the number of tubercles, and may apply to a case which is confined to one of the body cavities.

(1) The carcass may be passed when the lesions are limited to one group of lymphatic glands or one other organ.

(2) The carcass may be passed when the lesions are limited to two groups of visceral lymphatic glands in either the thoracic or the abdominal cavity.

(3) The carcass may be passed when the lesions are limited to two visceral organs (other than lymphatic glands) in the thoracic or the abdominal cavity, provided the lesions are slight, calcified, and encapsulated.

(4) The carcass may be passed when the lesions are limited to one group of visceral lymphatic glands and one other organ in the thoracic or abdominal cavity, provided the lesions in the affected organs are slight.

(5) The carcass may be passed when the lesions are confined to two groups of visceral lymphatic glands and one other organ in the thoracic or the abdominal cavity, provided the lesions are slight, calcified, and encapsulated.

(6) The carcass may be passed when the lesions are confined to the lungs, the cervical lymphatic glands, and one group of the visceral lymphatic glands of the thoracic cavity, provided the affection is slight and the lesions are calcified and encapsulated.

(7) The carcass shall be condemned when well-marked lesions are discovered in both the thoracic and the abdominal cavity.

up again. When such animals, while they still appear to be perfectly well, are bought in good faith and placed in a healthy herd they bring the disease and not infrequently transmit it to other animals. Various manifestations of the disease are seen in Figs. 33-36.

It is very likely that some animals, especially cattle, are infected and recover. This is to be expected in some cases where they are

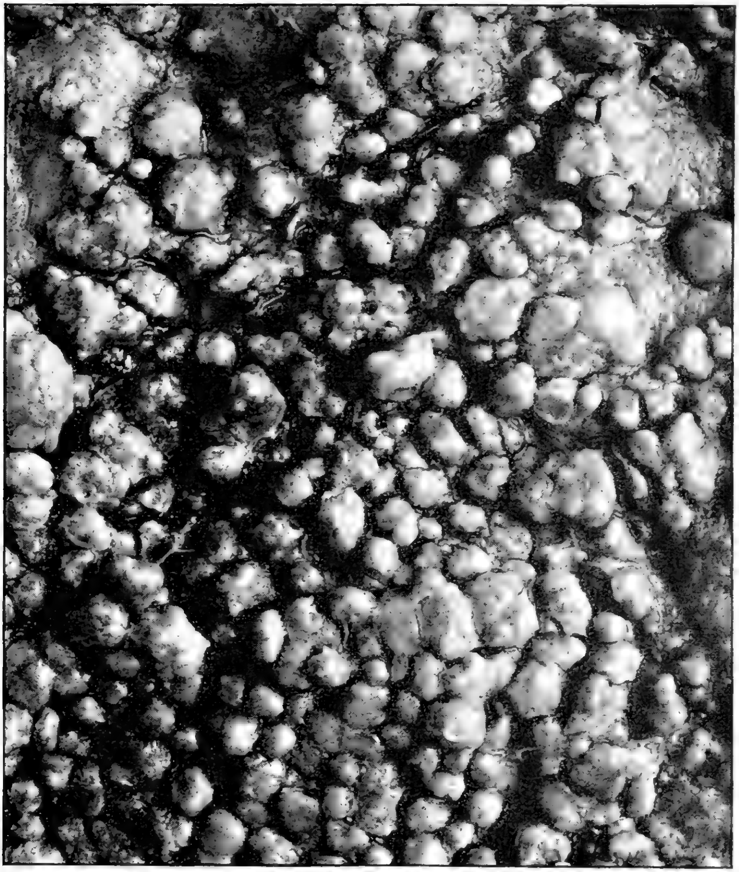

Fig. 35.—*A photograph of the tubercular nodules on the omentum (covering the intestines) of an advanced case of generalized tuberculosis.*

kept under favorable hygienic conditions. At present, however, our knowledge of recovery from tuberculosis in cattle is too meager to warrant much encouragement from this source. It appears to be safer and more economical not to trust to a recovery.

5. How to Detect Tuberculosis in Cattle.

From what has been said about the course of the disease, it is perfectly clear that there may be a large number of animals in a herd that are infected with tuberculosis but which appear to be sound. There may be others in which the disease is far advanced and the animals show that they are affected. There are two ways by which the disease can be detected, namely, by a physical examination and with tuberculin.

The physical examination is of value in advanced cases only, or where the diseased part is in evidence, as for example in the lymphatic glands of the neck. Experience has shown that by this method one is unable to find more than a very small percentage of the animals that are tuberculous and a menace to the healthy cattle. This method, therefore, is a very crude one and cannot be trusted except in the very advanced cases and in those where the early stages of the disease are in evidence externally.

The tuberculin test is far more reliable. There have been many unjust things said about tuberculin and many cattle owners have come to fear that it is a dangerous agent to use. It has been found, however, that tuberculin is as harmless as need be to the health of the animal. The dangers that are supposed to come from it are the results of poor tuberculin, unclean instruments, or other avoidable causes.

Tuberculin is the liquid, usually glycerinated bouillon, on which the tubercle bacilli have multiplied or grown. It is concentrated after heating and removing the bacteria and a little carbolic acid or thymol is added to preserve it. The active principle of tuberculin is a substance resulting from the multiplication of the tubercle bacilli in the liquid. In its preparation it is necessary that the tubercle bacilli "grow" sufficiently, which usually requires several weeks before the liquid is used. The flasks containing "cultures," as they are called, are, when ready, heated for some time at the boiling point. The liquid is then filtered to remove the bacilli, the fluid is then concentrated over a water bath. It is again filtered through a porcelain filter and stored. It will be noticed, that tuberculin is heated at two different times during its preparation sufficiently to kill the tubercle bacilli and it is also filtered through a substance that would remove the tubercle bacilli, if any escaped the first filtration. When ready for use tuberculin is a clear, amber-colored liquid. The intensity of its color varies according to the amount of blood pigment in the meat from which the bouillon was made.

Tuberculin cannot possibly produce tuberculosis, because it does not contain any tubercle bacteria. It does not excite a latent tubercle into activity. It is used the world over, and as yet no authentic report of injury caused by its use has been recorded. All those who have worked with tuberculin are agreed that it is one of the safest and surest tests in detecting the presence of tuberculosis that is known to the medical world. All are agreed, however, that it must be *properly used*, and that all those physical conditions that would tend to interfere with it must be avoided. If in its use these precautions are taken, tuberculin is as sure as any chemical reaction.

If the animal is sound when tuberculin is injected no reaction is observed. If, however, the animal contains an active tubercle there is a reaction which shows itself in a rise of the temperature beginning from 8 to 16 hours after the injection and continuing for from 6 to 10 hours and possibly longer. Fig. 30 shows the curve of the temperature reaction after injecting the tuberculin in a tuberculous animal.

It is stated, however, on good authority, that animals in advanced pregnancy, give a rise of temperature when they are not tuberculous. Cows in this condition should not be tested. They can be isolated until a few weeks after delivery, when the test may be applied. It is likewise asserted that occasionally animals in a very advanced stage of the disease will not react. The animal in this case, however, is easily recognized to be in a very bad condition. These and other conditions that might modify the reaction must be understood by one who is using the tuberculin. It often happens that other causes give rise to a temporary elevation of temperature during the testing period. These are readily differentiated from the tuberculin reaction by the character of the temperature curve.

It must be remembered that tuberculosis when naturally contracted may have a long and variable period of incubation. The tuberculin does not give a reaction during this period. It is possible, therefore, that an animal that has been associated with and infected by tuberculous cattle will not react, but will do so in from three to six months thereafter, or as soon as the diseased process has actually begun. While tuberculin is a most reliable diagnostic agent when properly used, it may lead to erroneous conclusions when improperly applied.

6. How to Eliminate Tuberculosis From a Herd.

A few years ago this could not be accomplished without sacrificing all the animals. With tuberculin, however, it is not difficult to detect all diseased individuals.

FIG. 36.—*A photograph showing the tubercular deposits on the pleural surface covering the ribs of an advanced case of generalized tuberculosis.* (*Reynolds.*)

The question arises, what can be done with the reacting animals? The examination of a large number of cattle that have been killed after the test, shows that a small number in every herd containing reacting animals are very extensively diseased and would undoubtedly have died in a short time. These are of no value and should be destroyed. Usually they are poor, and will not take on flesh. A much larger number of the reacting animals are but *slightly* diseased. These will readily take on flesh and can be fattened and used for beef. They must be carefully examined when killed, and if the disease is found to be extensive or in the two large body cavities, the carcass must be condemned. The government meat inspection regulations permit of the use of the meat of slightly tuberculous animals for food. These animals, therefore, have a beef value.

If the reacting cows are valuable, they can be isolated and kept for breeding purposes by removing the calves at once and feeding them on milk from healthy cows. The milk of the reacting cows can be used if it is sterilized first.

7. How to Prevent Tuberculosis.

As the most common method of introducing tuberculosis is by the purchase of a diseased animal, or feeding the milk of such animals, the most effective way to prevent the disease is not to do those things. Buy all animals on a tuberculin test, and retest after three to six months. Do not feed skimmed milk that comes from tuberculous herds to calves without first sterilizing it. The method is simple. The disease is produced by the tubercle bacilli and if we keep these bacteria away from our cattle they cannot possibly develop tuberculosis.

8. Necessity for Field Experiments for the Study of Animal Diseases.

A careful review of our present knowledge of bovine tuberculosis shows that while we have many important facts concerning it, we still need further information. This information can come only from actual investigation on a considerable number of animals living under what might be considered normal conditions. In order to know the best, or at least the most economical method of dealing with tuberculin-reacting animals, we need to have more knowledge concerning the recovery of the slightly affected individuals and the conditions of the diseased processes in the cases that fail to react on the second test. We have very definite knowledge as to the means of infection, the course of the disease in the beginning and in the fatal cases, but the course of the disease in the cases that appear to recover needs yet to be determined; and we need also to know how such animals shall be handled with safety to themselves and to others. Vaccination or immunization of cattle against tuberculosis is now being advocated, but before our cattle owners accept such recommendations they must be assured by carefully conducted experiments that the methods are genuine and that the results will be satisfactory.

The millions of dollars invested in cattle in New York State and the importance of the cattle industry to the general welfare of the State, demand that no effort should be spared to secure the most perfect knowledge of tuberculosis and also of other serious animal diseases. From the very nature of the case this information cannot be forthcoming without ample opportunities for investigation. We must supplement the laboratory and stable work with actual field work on a farm or farms that are devoted to these particular purposes.

March, 1905 BULLETIN 227

CORNELL UNIVERSITY

AGRICULTURAL EXPERIMENT STATION OF THE COLLEGE OF AGRICULTURE

Department of Botany

MUSHROOM GROWING

FOR AMATEURS.

By GEO. F. ATKINSON and ROBERT SHORE.

ITHACA, N. Y.
PUBLISHED BY THE UNIVERSITY

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Office of the Director, 17 Morrill Hall.

The regular bulletins of the Station are sent free to persons residing in New York State who request them.

MUSHROOM GROWING FOR AMATEURS.

Many letters are received asking for information as to the cultivation of mushrooms. These inquiries come chiefly from those who wish at the present at least to undertake the cultivation of mushrooms on a small scale, probably for private consumption, or perhaps also to furnish a small quantity for the market. To furnish directions for the successful cultivation of mushrooms by the amateur grower some experiments have been made in order to determine what success might be expected where no special houses and no elaborate preparations are made for their cultivation. These are the conditions under which most amateur growers must work. The present bulletin describes briefly the methods to be employed for the cultivation of mushrooms under these conditions. There is not room here to go into any detail concerning the experiments on which this bulletin is based; but before proceeding to a description of the methods to be followed it may be well to state briefly the conditions under which the mushrooms were grown and an outline of the experiment. The mushrooms were grown under two different conditions: First, in boxes under benches in the greenhouse, the part of the greenhouse where the temperature during the winter is about 55° F. at night and from 60°–65° F. during the day except on bright sunny days, when the temperature may go as high as 70°; second, a space under a potting table in a small basement room was used for making up another bed.

The space under the bench in the basement was made into a bed by placing a plank in front against the legs in order to support the material. The material then was packed directly on the basement floor and against the stone wall behind. Boxes were used under the benches in the greenhouse. These were most convenient to handle under the low bench of the greenhouse because the space was quite wide. These boxes were about 3x3½ feet wide and one foot deep. There were five of these. The space in these boxes together with that under the bench in the basement made a total of about 90 square feet. Up to the present time, 181 pounds of mushrooms have been picked from this area from one planting of spawn, practically two pounds per square foot.

The manure was obtained and composted October 31st. By November 9th it was cured and ready for putting in the beds. The temperature of the material in the beds was suitable for spawning on November 23d when the spawn was planted. The beds were cased in the basement on December 1st, in the greenhouse December 2d. The first mushroom was picked about January 1st, that is, five weeks from spawning the beds. In six weeks we began picking regularly; at first a few, the number gradually increasing, and then diminishing again as the beds became exhausted. A space representing about

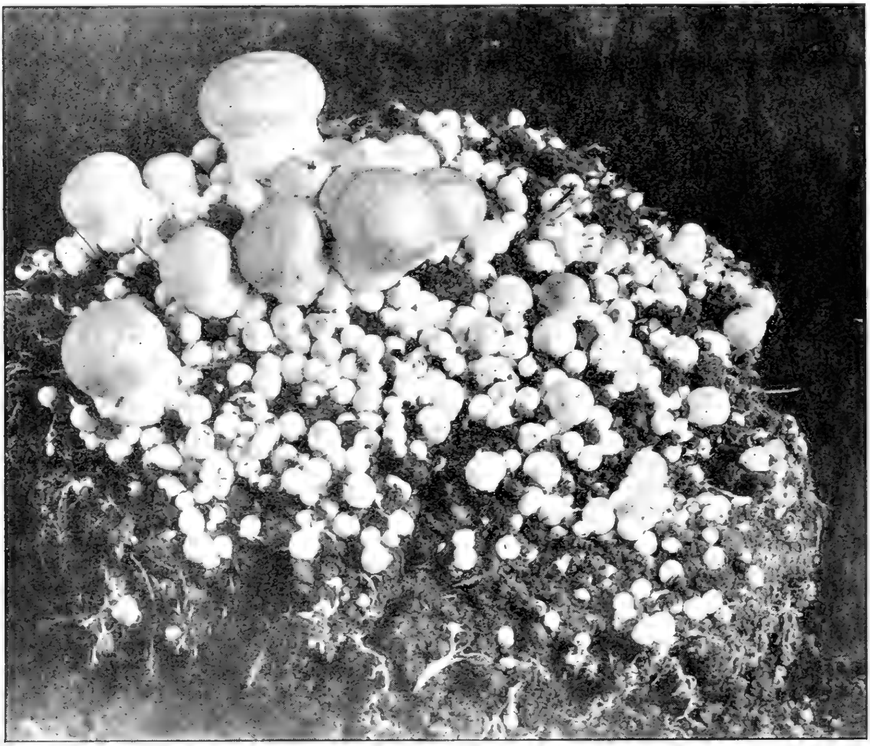

FIG. 151.—*Young stage of mushroom showing spawn, the minute fruit bodies and young button mushrooms. Variety Columbia.*

70 to 75 square feet ceased bearing about March 20th; the remaining space was bearing its heaviest about April 1 to 10th. For some reason the spawn in this part of the bed was very late in starting. It was fully two months after spawning before any evidence of mushroom growth appeared. The mushrooms usually were picked every other day and when the crop was at its best bearing from 4–8 pounds were collected at each picking.

FIG. 152.—*Variety Columbia. Grown in boxes under bench in greenhouse*

PLACES SUITABLE FOR GROWING MUSHROOMS.

Cellars or basement rooms where the temperature in the winter does not go below 55° or does not rise above 65°, are suitable places for growing mushrooms. It is not advisable to make them under the living part of the house, since the odor of the manure will fill the house. They can also be grown in stables which are not too cold in the winter. If grown under benches in greenhouses, the beds must not be too near heating pipes, and an oil cloth screen must be sloped under the bench to turn off the drip from water used on the benches above. Since this bulletin is prepared for amateurs, the question of the commercial growing of mushrooms in caves or in houses especially built for the purpose will not now be considered. Beds can be prepared on the cellar or basement floor by using the wall for one side of the bed. A board or plank one foot to 15 inches in width can then be stood on edge three to four feet from the basement wall and held in position by the necessary upright scantlings and supported at intervals to hold the material in position. In this way a box of the desired width and length can be made, the floor of the basement or cellar serving as the bottom. If more space is desired, tiers of beds can be made; that is, two or three or four beds one above the other against the cellar wall. This is a common practice. Cross pieces from the uprights can be nailed on, upon which the floor of the upper beds can be laid. These should be made of lumber at least one inch in thickness. A space about 20–24 inches should be left between the top of one bed and the bottom of the one directly above it. All these places should have some ventilation, but there should not be air currents and care should be taken to make the rooms in which the mushrooms are planted clean and sweet in order to avoid as far as possible any conditions which would encourage insects and other enemies of mushrooms.

PREPARATION OF MATERIAL.

The best material which has been found for the cultivation of mushrooms is horse manure as it comes from well-littered stables. The best is that which is littered with straw, though manure littered with shavings or sawdust is used, but it usually requires a longer time for curing. While it is desirable to have some straw in the manure, a large percentage of straw is objectionable, and when a large amount of straw is present the coarser straw should be removed. The manure is then piled under shelter either in the stable or in some shed. During the summer or autumn it may be piled in an open shed. In the winter when it is quite cold, an open shed would probably in-

FIG. 153.—*Variety Alaska. Grown in box under bench in gre'nhouse. Photograph of one clump in position, showing 20 full-grown mushrooms.*

terfere with proper curing. The manure is piled from 3–4 feet deep according to the amount needed and the space available. The length or width of the pile is immaterial. The manure is cured by allowing it to heat and ferment in the pile, but great care must be exercised not to allow it to burn, that is, it must not get white inside. To prevent its becoming too hot, the manure must be forked over and made into a new pile. This is done by beginning at one end, turning the manure over, shaking it slightly as it is turned into the new pile. It may feel to the hand quite hot, but as long as it does not turn white or get too dry the heating will not harm it. Usually after the manure is well heated, turning once in two or three days will answer, but sometimes it is necessary to turn every day. This will depend on conditions; and the conditions of the manure must be examined every day in order to prevent its burning or becoming too dry. It is far better to handle the manure in such a way as to avoid the necessity of moistening with water; but if it is too dry to begin with or if it becomes too dry in the process of heating, enough water should be sprinkled on to make it moist, but not wet. It usually requires from 10–15 or 18 days to cure manure, and it is then ready for making into beds. It should not be made into beds, however, until the temperature of the fermenting manure is down to about 100° Fahr.

PREPARATION OF THE BEDS.

Having prepared the boxes, the manure can now be placed in them. The manure is either used alone or with the mixture of some rich loamy soil, about one part of soil to four or five parts of manure. Most commercial growers of mushrooms do not employ any soil, but use the manure pure. This gives much less trouble and is usually considered a more successful method than the mixture of soil. When the beds are made up without soil, a layer of manure is spread over the bottom; usually the coarser and more strawy material is selected for the bottom layer, since this ferments for a longer time and keeps up the heat in the bed. When the first layer of manure is thoroughly tramped or pounded down, another layer is added which in like manner is thoroughly tramped down. This is continued until the bed is filled, when the manure should be from 10–12 or 14 inches deep and must be firmly packed. In using soil to mix with the manure, a layer of the manure is first put in the bottom of the bed as described. Over this is sprinkled a thin layer of soil. Another layer of manure is then added and another sprinkling of soil. Each time the layers are thoroughly packed down, as before, until the beds are filled.

In the experiments described above, soil was mixed with the manure. Where soil is used, care should be exercised in its selection

It should be a good, loamy, rich soil. The best to use is rotted sod, since in the decaying roots and stems there is considerable fresh organic material which is excellent food for the mushrooms. This is the kind of soil used in the experiments described above. Any good pasture sod or good sod by the roadside in rich earth will answer. It is composted without the addition of any other material, and in the course of two or three months composting in the summer it will be ready for use. It should be worked up fine and screened from coarse stone, sticks, etc.

PLANTING THE SPAWN.

When the beds are first made up, if the work has been properly attended to, they will not be in a condition for spawning because the temperature will run too high. If the manure in the pile was at a temperature of about 100° when it was made into the bed, the temperature in the bed is likely to rise higher, up to 115° or 120° F. because of its being packed down so closely together. A thermometer should be kept in some part of the bed and if the bed is large the temperature should be tested at different places every day or so. The temperature should be taken several inches below the surface. The proper time to spawn is when the temperature is from 70° to 75° F.

What mushroom spawn is. Mushroom spawn as it is found in the market is either in the form of bricks and known as brick spawn, or it is in the form of irregular chunks of manure with the fibrous growth of the mushrooms, known as the vegetative part or mycelium, growing in it. This latter is known as French spawn. Suitable pieces of spawn for planting are those about two inches in diameter. If brick spawn is used, a single brick will make 9 to 10 or 12 such pieces. These are planted according to the wishes of the operator from 8 to 10 or 12 inches apart in the bed. The first row is planted four or five or six inches from the edge of the bed. In the second row the pieces may alternate with those in the first. A hole is well made by a dibble or sharpened stick, which is thrust into the bed and moved around in order to make a hole which will admit the pieces of spawn. The hole should be small enough so that when the spawn is pressed into it, it will fit very tightly. The spawn should be planted from one to two inches below the surface of the bed and then covered with the manure removed in making the hole. This should then be packed down hard. The beds are then left in this condition for about a week, and in the meantime may be covered loosely with excelsior or straw to prevent too rapid evaporation of moisture and also to prevent too rapid lowering of the temperature.

FIG. 154.—*Variety Bohemia. Grown in bed under bench in basement potting room. Flash-light photograph. In the central clump, the three large mushrooms weighed 1 pound 3 ounces.*

CASING THE BEDS.

This consists in covering the beds with an inch to an inch and one-half of good soil, the same kind of soil as is used for mixing in with the manure. The object in casing the beds with soil is to retain the temperature within the material, which is necessary for the maintenance of the growth, and it also provides a firmer and cleaner substratum in which the stems of the mushrooms are mostly formed and they are thus cleaner when picked. In from six to seven weeks mushrooms should begin to appear.

FORM AND GROWTH OF THE MUSHROOM.

For full discussion of the form and growth of the mushroom, the reader is referred to Bulletin 138, Cornell University Agricultural Experiment Station, Studies and Illustrations of Mushrooms* No. 1, but a brief description may be made here. The mature plant is somewhat umbrella-shaped, having a cap, the expanded upper part, which is borne on a stem. Near the upper part of the stem is a collar known as the ring or annulus. On the underside of the cap are the gills. These are thin long plates, something like the blade of a knife, which radiate outward from near the stem and lie very close together. These gills are called the fruiting portion of the plant, because they bear on their surfaces the minute germs or spores by which the plant is distributed and sometimes reproduces itself. These spores are developed in great numbers. They are dark brown when ripe. They easily fall from the plates or gills when ripe, as is seen by placing a cap on white paper for a few hours, when a beautiful spore print is formed from the large number of spores which fall down on the paper. Where mushrooms are growing in a clump, the upper ones when mature shed their spores on the caps of the lower ones, giving them a sooty-brown appearance.

Growth of the mushroom. I have just said that these spores sometimes serve to reproduce the plant. They perform the service for the mushrooms which seed perform for the higher plants, but they are not true seeds. The spores are very light and are easily wafted about by the gentlest breeze, so that in the fields the winds scatter the spores far and wide, and thus give an opportunity for the mushrooms to grow in fields where food and other favorable conditions are

*See also Mushrooms, Edible, Poisonous, etc., Henry Holt & Co., New York City, in which is a 40-page chapter on the cultivation of mushrooms in houses constructed for the purpose and in caves. See also Farmers' Bulletin 204, U. S. Dept. Agr.

present. These spores germinate by producing a very delicate white thread which branches to form a mat of fiber-like substance. Many of these little threads unite into a cord or string which is also white and is shown very well in Fig. 151. This fiber-like substance is known as the mycelium, though mushroom growers often speak of it as the "fiber." It can readily be seen in all good spawn. In practical mushroom culture, the spores of the plant, though they serve as seeds, are not used for planting since the use of mycelium or fiber is a far better means of propagating the mushroom.

After the pieces of brick are planted in the bed, the moisture is absorbed which gives the mycelium the water which it needs for growth. The heat from the fermented manure supplies the necessary temperature, and growth of the fiber soon begins. It spreads out into the material of the bed and also grows upward into the soil with which the bed is cased. In the soil and in the manure of the bed, it forms a large mat of these fibers or mycelium cords. Finally when a sufficient mass of the mycelium has formed the mushrooms begin to develop. The mushrooms are formed by the growth of a large number of the same delicate threads, but a larger number of them grow together and they grow upright. First is formed a minute rounded body the size of a mustard seed. This becomes larger until it reaches the button stage of the mushroom, shown in Fig. 151. This same figure shows a very young stage of the buttons when they appear as minute rounded bodies on the cords. Sometimes the spawn will grow very profusely above the piece of brick which has been planted and appears on the surface of the soil. When this is the case, large numbers of minute buttons make their appearance and form very beautiful objects. All of these, however, do not make mature mushrooms, since there is not food enough for all. Those which get the start grow to maturity, while the smaller ones die. As the button stage is reached, the upper part expands into the cap. The stem is shown as a short cylinder. The gills are formed within the upper part of the button and are first covered by the outside mass, which stretches as the cap expands to form the veil. Finally this veil breaks, exposing the gills on the underside, and hangs down on the upper part of the stem as the collar or annulus.

PICKING THE MUSHROOMS.

The mushrooms are ready to pick about the time the veil breaks. At this time the gills are a bright pink color. As the plant gets older, the cap expands more and the gills gradually become dark brown or black because of the large number of ripe spores on them. Even in this condition they are suitable for eating if they are not decayed. But when the gills become black, they are not so suitable for the market. In picking the mushrooms, the best way is to take hold of the plant by the cap. By moving the hand from side to side with a slight circular motion the stem is freed from the soil. The end of the stem to which the dirt clings should be cut off and discarded. If any dirt comes up which contains the fiber of spawn, this part should be replaced in the bed. After picking the mushrooms, wherever the stems have made a little hole in removing them from the earth, a little soil should be added to cover this up again.

THE SPAWN.

Spawn can be obtained from any of the large seedsmen. The spawn handled by these firms is imported. The spawn used in the experiments on which this bulletin is based was obtained from the Pure Culture Spawn Company of Columbia, Mo. This firm has on the market three varieties of spawn known as the Alaska, Columbia and Bohemia, the first kind a whitish one, and the two latter with a brownish cap, the Bohemia being a stouter mushroom than the other two. It is possible with the method employed by this company to cultivate varieties true to name because the spawn is derived from known varieties, whereas most or all of the imported spawn may contain several varieties mixed.

ENEMIES OF MUSHROOM CULTURE.

Mushrooms are subject to a number of troubles which sometimes interfere seriously with the crop. When the manure is poor there is likely to be trouble from the fly. A large number of little maggots are developed which feed in mushrooms. Mites are sometimes very troublesome. Both of these troubles are likely to be more serious in the warmer weather. Snails also, which are troublesome in greenhouses, are very fond of mushrooms. Lettuce leaves or cabbage leaves should be placed near the beds or even on the beds, and the beds should be visited at night when the snails are troublesome. Then the mushrooms damp off or fog off. This is usually caused by too much moisture on the surface of the bed. The beds need sprinkling occasionally with tepid water, but should never be made very wet. Insects can largely be avoided by care in securing good manure and in having the premises well cleaned before the beds are made. When mushrooms are grown in successive years in the same place, the place should be given a very thorough cleaning during the summer. All manure and soil is removed, the beds are cleaned out well, and the walls and boards often whitewashed. It perhaps would be well also at this time thoroughly to disinfect the premises with a solution of formalin.

G. F. ATKINSON.
ROBERT SHORE.

April, 1905 BULLETIN 228

CORNELL UNIVERSITY

AGRICULTURAL EXPERIMENT STATION OF THE COLLEGE OF AGRICULTURE

Department of Agronomy (Extension Work)

POTATO GROWING IN NEW YORK

(AND LIST OF COOPERATIVE EXPERIMENTS.)

By J. L. STONE.

ITHACA, N. Y.
PUBLISHED BY THE UNIVERSITY

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College of Agriculture,
Cornell University, Ithaca, N. Y., *April* 1, 1905.

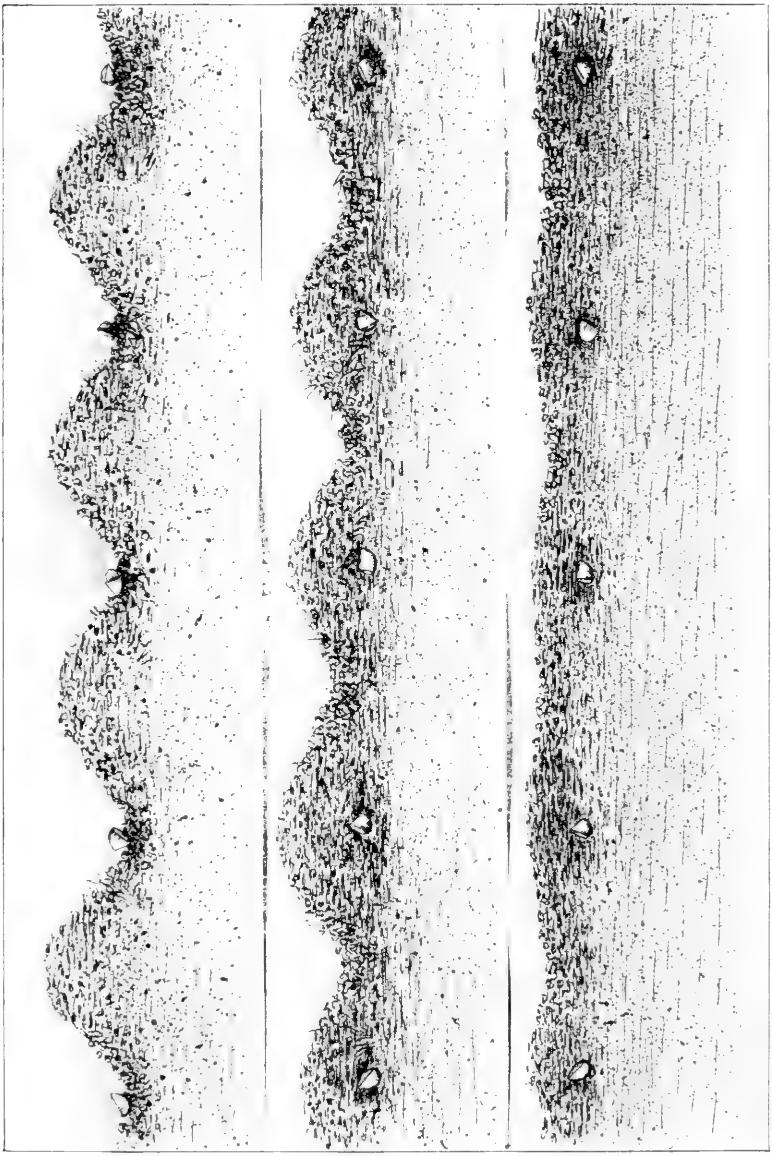
Hon. Charles A. Wieting,
Commissioner of Agriculture, Albany.

Sir.—I herewith submit an expository bulletin on potato growing in New York State, embodying the experience of the best potato farmers and the results of numerous scientific experiments.

Next to rice, the potato is probably the most extensively grown and most valuable crop in the world. The potato crop of Europe in value and volume exceeds the tabulated wheat crop of the world. According to the last census the crop in the United States was 273,328,207 bushels, of which New York State produced 38,060,470 bushels, or slightly less than one-seventh of the entire crop of the United States. The New York crop was grown on 395,640 acres of land and was valued at $15,019,135. New York has ranked first in potato production in every census year since 1850. The average yield of potatoes in the United States for a ten-year period is 84.5 bushels an acre and in New York State for the same period it is 81.2 bushels. The average yields secured in England are from 230 to 240 bushels; in Norway, 220 to 230; Germany, in 1903, 217 bushels; In Ireland, in 1904, 159 bushels. The potato crop of the world now averages about 4,500,000,000 bushels per annum. Following are figures of potato crops for the year 1904:

	Acreage.	Yield per acre.	Total production.	Value.
U. S.	3,015,675	110.4	332,830,300 bu.	150½ millions of dollars
N. Y.	442,254	93. bu.	41,129,622 bu.	22⅜ "

Respectfully submitted,
L. H. Bailey, *Director.*



155. *Land prepared for potatoes, showing respectively the furrows opened, the seed covered, and condition after harrowing.*

POTATO GROWING.

Five bulletins relating to potato culture have been issued by this Station. Bulletins 130, 140, 156 and 196 record results secured on the Station grounds and 191 results of co-operative experiments under the university extension movement. These bulletins have had a wide reading and requests for them are still numerous. Some of them, however, are now out of print and it is decided, instead of reissuing the separate numbers, to combine into a new bulletin a summary of the data contained in them, with such new data as has accumulated. The aim is to present a logical expository bulletin on potato culture, using the experimental data to illustrate and enforce the statements made.

Soil. Potatoes grow on a wide range of soils, but those in which either sand or clay largely predominate are not desirable. Potatoes prefer a cool, moist, mellow soil, and it must be well drained either naturally or artificially. These conditions can usually be secured in a sandy or gravelly loam, if rightly managed. There should be enough coarse material in the soil to insure friability and enough silt or clay to insure water-holding capacity. An abundant supply of humus is desirable in soils of any grade. It helps to make the stiff soils more permeable and friable, and the loose soils more retentive of moisture. In both it is an important source of plant-food, while its presence favors the bringing of the minerals of the soil into available condition.

The physical texture of light soils is favorable for potatoes and if suitably fertilized they will produce larger crops than heavy soils. This is shown by the variety tests recorded near the end of this bulletin. The potatoes grown on light or medium soils are also usually of superior quality to those grown on heavy soils. An interesting illustration of this occurred near the University the past season. A field having a mellow loamy soil on one part and changing to rather a heavy clay loam on another was planted to potatoes. The whole field was well fertilized and tilled, the different soils being treated alike. It chanced that the first potatoes to be harvested were taken from the area having the lighter soil. These potatoes were furnished to customers who pronounced them of excellent quality and at once placed orders for their winter's supply. These orders were filled with potatoes taken from the area having the heavy soil and proved to be of very inferior quality, to the annoyance and disgust of both seller and buyer.

The soil upon which the Cornell experiments have been conducted is a gravelly loam underlaid by sand. The natural drainage is, therefore, very effective and the soil is better adapted to withstand an excess rather than a deficiency of moisture. Previous to the beginning of these experiments in 1895, the land had been subjected to a regular four years' rotation consisting of wheat, clover, corn and oats. In 1894 the area was planted to corn, having received about 10 tons per acre of barn manure during the previous winter. While this soil was recognized to be in a good state of fertility owing to previous rational treatment, it did not appear to hold an unusual stock of plant-food. In 1896 analysis of soil from these acre plats, computed for a depth of eight inches, indicated in the fine soil the following amounts of the constituents named below:

Phosphoric acid	2,523 lbs.
Nitrogen	2,049 lbs.
Potash	8,042 lbs.

In Roberts' "The Fertility of the Land" analyses of 49 soils are tabulated, and, computing for the same depth, the average amounts of potential plant-food per acre are:

Phosphoric acid	4,219 lbs.
Nitrogen	3,053 lbs.
Potash	16,317 lbs.

It appears, then, that this soil contained in the fine material only about one-half as much phosphoric acid and potash and about two-thirds as much nitrogen as an average soil. The gravel which did not pass through a sieve of 18 meshes to the inch and which constituted about 42 per cent of this soil, contained somewhat more phosphoric acid and slightly less potash per acre than did the fine soil. Some of this gravel was in a soft, rotten condition and pulverized very easily. For six years experiments in the culture of potatoes were conducted upon this area, though potatoes did not follow potatoes year after year on the same plats. The potato crops alternated with crops of beans, sugar beets, corn or oats, and peas. Large yields of these various crops were taken from these plats each year and without the application of manure or fertilizer, the object of the series of experiments being to demonstrate the effect upon the yield of very thorough and judicious tillage of the soil.

Place of potatoes in the rotation. In all the plat experiments with potatoes conducted at this Station, the potatoes were planted on land that had been tilled the previous season. As results to be stated further on will show, during the earlier years of these experiments, the soil still carried a fair amount of organic matter derived from previous growth of sod or dressings of manure. This resulted in almost ideal conditions for the crop. The absence of undecomposed sods made possible the thorough, deep preparation of the soil and the deep planting which we have found so favorable to good results. An inverted clover sod is recognized by practical potato growers as an excellent place for potatoes. If the sod is newly turned, however, it interferes with the through preparation and deep planting which is desirable. The ideal preparation is to turn the sod early the previous autumn, plowing as deep as the character of the land will permit, and sow rye or rye and vetch for a cover-crop. In the spring before the cover-crop has made large growth or become woody, the land is plowed again, but not quite so deep as before. The sod should be so decayed by this time as not to interfere with the working, but to mix thoroughly with the soil. If the spring plowing is done several weeks before planting and while the cover-crop is young and succulent, the cover-crop will decay quickly and not hinder tillage operations. If the cover-crop is allowed to make large growth and become woody, it not only will interfere with the planting operations but will endanger the crop should dry weather prevail, by checking rise of moisture from below.

A timothy sod is not so desirable for potatoes, but if it is to be used it should be plowed the previous August and sowed to a cover-crop. This gives it time to rot so it can be incorporated with the soil. The cover may be mammoth clover, or crimson clover (if it succeeds in the locality), rape, or buckwheat and rye. The rape will grow till severe freezing occurs, when it will die and in the spring will mix readily with the soil. About five pounds of seed per acre may be sown and lightly brushed in. The buckwheat and rye may be sown three pecks of the former mixed with five pecks of the latter. The buckwheat will overgrow the rye and hold it in check till frost occurs, when it will be killed and the rye will have opportunity to grow during late autumn and early spring till it is plowed under.

Land that has grown a crop of corn, beans or cabbage is an excellent place for potatoes, provided there is an adequate supply of available plant-food. If the previous treatment, so far as rotation and manuring is concerned, has been such that there is a fair stock of organic matter left in the soil after growing the preceding crop, then thorough tillage will probably make available adequate supplies for the potato crop. This applies to soils of medium or heavy grade rather than to sandy soils.

Preparation of the Seed-Bed. Potatoes thrive best on a deep, well drained, moist, mellow, cool soil, and the preparation given to the seed-bed should aim to bring about these conditions as fully as possible. The suggestions made as to place in the rotation have this point in view. Undecomposed sods interfere with thorough preparation and working of the soil, but when broken down and mixed with the soil the effect is highly beneficial.

In the Cornell experiments the fitting of the land was very thorough and was alike for all the plats, the plan of the experiments having to do with the inter-tillage, spraying, etc., of the crop. It is evident, however, that the fitting had very much to do with the result, since those plats that were given the most common treatment after the plants were up, nevertheless produced very satisfactory crops.

This is shown in the following table giving the minimum, maximum and average yields and also the average yield in the State for the years 1895 to 1898 inclusive.

TABLE I.—YIELD OF POTATOES OBTAINED ON CORNELL UNIVERSITY EXPERIMENT STATION PLATS, 1895 TO 1898.

YEAR.	Number of plats grown.	Minimum yield per acre.	Maximum yield per acre.	Average yield per acre.	Average yield in New York.
		Bushels.	*Bushels.*	*Bushels.*	*Bushels.*
1895	8	304	415	352.6	122
1896	9	245.3	350.3	319.4	89
1897	10	243	384	322	62
1898	11	206	398.6	292.3	73
Average for four years	....	249.5	387	315.4	86.5

This land did not contain large amounts of nitrogen, phosphoric acid or potash, as shown on page 430. It had no manure or fertilizer after the winter of 1893–94. It produced heavy yields of other crops the alternate seasons when it was not planted to potatoes. The difference between the minimum and maximum yields is due to the difference in the treatment of the crop after it was up; but the very creditable yields given in the minimum column evidently must have depended upon the preparation given the soil before this time, for afterwards these plats had the very commonest treatment— that is, they were "laid by" at the third cultivation.

Fitting the Experiment Plats. Each fall as soon as the season's crop was removed the land was deeply plowed, thoroughly harrowed and sowed to a cover-crop. This cover-crop was usually wheat or rye. Once a good stand of crimson clover was secured. Sometimes the cover-crop had time to make only a small growth before winter set in. In the spring, without waiting for the cover-crop to grow, the land was plowed as soon as the soil was dry enough. In this climate the soil and subsoil are almost sure to be thoroughly saturated with water at sometime during early spring. Owing to the porous subsoil the surplus in this case would soon drain away and the early plowing would check loss of capillary water by evaporation from the surface. Professor King has shown (see "The Soil," p. 188) that an unplowed Wisconsin soil lost by evaporation in seven

FIG. 156.—*Covering potatoes by Cornell method.*

days in April nearly 200 tons of water per acre, more than was lost from the same soil that had been plowed. Usually the potato crop is limited at some season of its growth by the amount of moisture that is available. By early spring plowing and by maintaining an earth mulch thereafter, we probably conserve a maximum amount of the winter's rainfall for the use of the crop in its time of need. The twice plowing and frequent harrowings that the land has received have thoroughly pulverized and aerated the soil and put it in favorable condition for chemical and bacterial activity. The method employed in planting also results in a much greater movement of the soil than is usually secured in this operation and should be considered as part of the tillage given the land before the crop is up.

The various steps in the planting operations are illustrated diagrammatically in Fig. 155. Furrows were opened deeply by means of a double mold-board plow, piling the earth up in ridges between the rows. The tubers were dropped in these furrows and the ridges were split, using the same implement and throwing the earth into ridges over the rows; Fig. 156. By these operations the whole body of soil was stirred nearly to the depth of the original plowing and as effectively as the plow would do it. Before the potatoes were up the land was leveled by harrowing.

We desire to emphasize the fact that up to this point the soil probably received, in the two plowings, the planting and the subsequent harrowings, double the amount of effective tillage that is ordinarily given to the potato crop in New York. It is this thorough fitting of the soil which all the plats received, that made possible an average minimum yield of 249.5 bu. (see table, p. 432) per acre during four years 1895–98, on land that was not manured or fertilized after the winter of 1893–4, as the after-treatment on these minimum plats was only the commonest. The difference between this average minimum yield of 249.5 bushels and the average maximum yield of 387 bushels, or 137.5 bushels, is attributable to the treatment given the crop after the plants were up, which is yet to be considered.

Fertilization. The experiments under discussion were not planned to consider the question of fertilization of potatoes, but to demonstrate the efficiency of thorough tillage. It seems wise, however, in this connection to refer briefly to the use of barn manure and commercial fertilizers in potato growing.

The potato crop requires an abundance of available plant-food in order to make large yields. Sometimes thorough preparation and tillage of the soil will render available all the crop can use. Usually however, the crop responds well to dressings of manure or fertilizer, and this is especially true in case only ordinary tillage is given. Therefore, unless the soil is known to be in fertile condition it is good policy to provide liberally for the requirements of the crop. The potato usually brings a larger cash return per acre than most farm crops and therefore warrants a relatively large expenditure for manure or fertilizers.

Stable Manure. Experience teaches that well rotted manure produces best results with potatoes. In fact, it is well if liberal applications have been made to the previous crop, so that the manure shall have become thoroughly decomposed and mixed with the soil before the land is devoted to potatoes. It is found that direct applications of manure aggravate the potato scab, if that trouble be present, but that the difficulty is not so great if the manure has been applied to the previous crop. It requires, however, a heavy application to be sufficient for two large tilled crops. In some localities, where the scab is especially troublesome, direct applications of barn manure to potato land have been abandoned and commercial fertilizers employed instead. If the land is to be fall plowed and sown to a cover-crop, the manure, if available, may well be applied at this time—plowing it under if coarse or working it into the surface if fine. The spring plowing will effect its thorough mixing with the soil.

Commercial Fertilizers. Commercial fertilizers are frequently used in New York on land to be planted to potatoes. Potatoes being a cash crop upon which considerable labor is expended and a crop which usually responds to such applications, this practice seems to be rational. This Station, however, has conducted few fertilizer experiments and readers are referred to the excellent bulletins on this subject issued by the State Experiment Station at Geneva and also to a popular discussion of the use of fertilizers in potato growing by Mr. Alva Agee in Bulletin No. 105 of the Pennsylvania State Board of Agriculture, Harrisburg, Pa., entitled "Potato Culture."

Selection of Seed. It is a fact of very general observation among potato growers that varieties possessing strong vigor and powers of large production tend to "run out" under the ordinary system of management. The potato thrives best in a cool climate. In the United States it reaches its highest development in Maine, New York, Michigan and the Northwest. Here degeneration is believed to be less rapid than in territory to the south of this belt, but the tendency exists. Some have thought that it is inherent in the system of propagating by means of tubers; that the only means of escaping its consequences is by having frequent recourse to new varieties recently developed from the seed. Growers in the more southerly districts believe they find that by securing seed from the North every few years, better crops are produced than from seed of the same variety that has been continuously grown in their own localities. It is believed that this tendency to lose vigor is least marked when the conditions of climate, soil and culture are those best suited to bring the plants to the highest degree of development, and that it increases as these conditions are departed from.

It is thought that, in New York at least, the "running out" of varieties is due in greater measure to the system of seed selection and care in common use (or rather to the lack of such a system) than to any tendency to degeneration inherent in the propagation by means of tubers. The cost of the frequent introduction of new varieties or sending to northern localities for fresh seed, is such that much of the area devoted to potatoes in New York is annually planted with tubers more or less reduced in vigor. If a system of seed selection that is practicable for the farmer to follow and would prevent the deterioration of the desirable vigorous sorts, so as to hold them up to their highest point of excellence, or, perhaps, even lead to their further improvement, were understood and practiced, it would increase the average yield per acre without materially increasing the cost.

Let us first consider the practice of farmers in seed selection and point out some of the causes that lead to deterioration of varieties. The tuber does not belong to the root system of the plant, but to the stem. It is not a true seed: that is in the seed ball. At a certain stage in its growth the plant throws out a branch or stem that, instead of rising above ground, and producing leaves, flowers and seeds, remains under the surface and at its extremity produces a cluster of buds (eyes) which are surrounded by and imbedded in a mass of succulent growth—chiefly starch, which constitutes the tuber. The nutrient material contained in the tuber is intended for the nourishment of the buds when they start to grow. The tubers tend to partake of the nature and characteristics of the plants that produce them. If the plant was a strong and vigorous one, having a tendency to produce a goodly number of large well-formed tubers, each of those tubers will partake of the characteristics of the parent and under favorable conditions will produce similar strong plants. If the plant is a weak one, having a habit of setting few tubers and growing these only to small or medium size, these tubers will also inherit and transmit the characteristics of the parent plant. A tuber from a vigorous plant producing a large hill of potatoes, though itself small because it was started late and did not have time to develop full size, would possess and transmit the characteristics of its worthy parent. So, also, the fair sized tuber from a weak hill in which it alone attained merchantable size, would inherit the tendencies of its parent. We see, then, that inspection of the individual tuber alone will not enable us to judge whether it inherits great vigor or not. To judge this we must know the character of the hill it came from, or back of this the vigor of the plant that produced the hill. The whole plant, then, must be studied as an individual—not the single tuber.

While the variety is new or when the stock has recently come from a locality where vigor is well maintained, nearly all the plants produce large hills of potatoes and a large yield per acre results. Some weak and inferior hills, however, are always found and in the absence of any system for excluding these from the next season's planting, their proportion to the whole increases from season to season with a gradual decline in productivity of the general stock.

This tendency is observed when the "run of the pile" is used for planting. It is much increased if, for the sake of economy, "seconds" are selected for seed. A second from a good hill may be excellent seed, but good hills produce few seconds, while the inferior hills produce little else than seconds. The farmer, then, who plants seconds is really selecting his seed in the main from the weak and inferior hills. Many farmers think that seconds are satisfactory for planting. This sometimes is true. If the stock is vigorous, so that nearly all the seconds come from good hills, little deterioration will be observed; but if the stock is already weakened so that most of the seconds come from inferior hills, the deterioration will be rapid.

Considerable experimental data gathered from numerous sources could be presented to sustain the above statements, but space limits us to one experiment extending through two years by the late Professor E. S. Goff with potatoes of the Snowflake variety.

TABLE II.—SHOWING YIELDS FROM MOST PRODUCTIVE AND LEAST PRODUCTIVE HILLS.

SEED FROM.	1898. No. of hills planted.	1898. Wt. of seed in gms.	1898. No. of tubers.	1898. Yield wt. of same in oz.	1899. No. of hills planted.	1899. Wt. of seed in gms.	1899. No. of tubers.	1899. Yield wt. of same in oz.	Total yield for the two years in oz.
Most productive hills.....	13	111	42	$41\frac{10}{16}$	32	323	190	$290\frac{1}{2}$	$332\frac{1}{8}$
Least productive hills.....	13	111	36	$12\frac{4}{16}$	32	323	159	88	$100\frac{1}{4}$

Care was taken to cut the seed so that in each case the same weight should be planted. The total produce of the seed from the most productive hills is nearly three and one-third times that from the least productive hills. Differences so marked have not always been obtained, but the tendency seems to be uniformly manifested.

It is evident, then, that tubers for planting should be selected on the basis of the character of the hills they come from, and that a system for making such selections that is practicable for busy farmers is much needed. We believe that the system about to be suggested is practicable and will prove profitable to farmers adopting it by enabling them to maintain at their highest state of productivity any varieties possessing desirable characteristics, great vigor and adaptation to their soil and markets. Probably they can go farther and even increase the productivity of their best varieties. At all events, seed selection is one of the important means of increasing the crop.

Most potatoes are these days dug by machinery, which does not permit of selection by hills. But it would not be burdensome for the farmer to dig by-hand the stock required for next season's planting. Let the necessary area be set aside from the best part of the field—where conditions are such that plants of high vigor are likely to be produced. Have the tubers from each hill laid by themselves, so that inspection of the hills will be easy. First go through, taking out and *discarding all inferior hills.* Next make a selection of *the very best—the gilt-edge* hills. These are for the planting of the next season's seed area. The remainder are for the planting of the main crop, and by reason of the exclusion of all inferior hills should produce increased yields over "the run of the pile." The next season the seed area planted with the *gilt-edge seed* should be harvested in the manner described above and should give still better stock for planting both the main crop and the seed plat the following year. Thus year by year the productivity of a variety should be maintained or improved instead of suffering the deterioration so generally observed.

It is possible to make decided gains in productivity by selecting on the basis of vigor of vine as manifested during the growing season. The best hills are usually the product of the most vigorous vines. If markers are placed by the most promising-looking plants and these taken out by themselves just before the general harvest, excellent stock is secured with which to start a seed plat. A Chautauqua County farmer who followed this system for three years, reports that he established a strain of a variety that was decidedly more productive than stock taken from the general harvest. This system of selection often may be combined with the one previously described to excellent advantage.*

Storing Seed Potatoes. The conditions under which tubers intended for planting are kept during the winter and early spring, have much to do with the vigor of the plants derived from them. If placed in

*This matter of the selection of potatoes for planting is admirably adapted for one of the co-operative experiments in our Agricultural Extension Work. We shall be pleased to enter into communication with farmers who are willing to take it up in this connection.

large piles soon after harvesting and while the weather is still warm, there is danger of heating to injure vitality. Potatoes should not be stored in large masses till the weather has become cool and they have been sweated in small piles. If stored in crates or in moderate sized slatted bins which favor a gentle circulation of air among them, the vitality is believed to be preserved in high degree. The temperature at which they are held, however, is of chief importance. The lower the temperature can be held without danger of chilling the tubers, the better. From 35° to 50° give good results. In many cellars these temperatures cannot be maintained, especially as warm weather approaches and the tubers start to grow. The sprouts produced in the darkness of the cellars are long, spindling, white and tender and are necessarily sacrificed when the tubers are handled. Plants produced from tubers thus weakened by premature sprouting in darkness are less vigorous than those from tubers held dormant till planting time or suitably sprouted in the light.

In 1903 the following experiment bearing on this point was conducted by this Station under the supervision of Mr. J. W. Gilmore. About May 5, Maine-grown stock of Sir Walter Raleigh variety that had been kept in excellent condition was set apart for seeding a late planted plat. Part of the seed was simply stored in a cool place in the barn and a part put into cold storage till July 6, when both were planted. The barn-stored seed was considerably wilted and had sprouts two or three inches long, which were mostly broken off in planting. The cold storage seed was just beginning to start into growth. The yields of equal areas were:

From barn-stored seed, wilted and sprouted	42.5 lbs.
From cold-storage seed, solid, slightly started	111.0 lbs.

This shows a gain of 159 per cent in favor of the solid, nearly dormant seed over the wilted and sprouted seed. This probably illustrates extremes, though the sprouted seed was not worse than we have frequently seen farmers using.

In 1904, another experiment was conducted under the supervision of Mr. S. Fraser. The seed tubers were stored from November to May in crates in a cool cellar. No sprouts had started May 1st. They were then divided into four lots and subjected to the conditions indicated below. The following figures give the produce of small uniform plats planted June 7th:

VARIETY.	Seed Stored 36 Days (May 2 to June 7) in Trays as Below.			
	In dark cellar 50°–60°. Average of four plats.	Cold frame open above, bottom 80°.	Barn near window temp. near out of doors.	Greenhouse 70° to 90°.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
Carman No. 3	15.44	26.50	21.25	16.25
Sir Walter Raleigh	16.74	17.00	20.13	20.25
Average of both	16.09	21.75	20.69	18.25
Increase over seed stored in cellar	....	5.66	4.60	2.16
Per cent gain over seed stored in cellar	....	35.1	28.5	13.4

The sprouts on all those exposed to light were strong, dark green, short, not over ½ to ¾ of an inch long. On those from the cellar they were three to four inches long, whitish and brittle and would be likely to be broken off in planting. If the planting is to be done by machinery, the tubers should not be exposed to light and warmth as long as were those in this experiment, as the sprouts, though strong and vigorous, were too long to escape injury if handled carelessly. Probably fifteen to twenty days' exposure is more suitable.

If the cellars or other usual places of storage will not hold the seed practically dormant till within two weeks of planting time, then cold storage should be resorted to if within reach, or the seed tubers may be stored in pits in the field and by proper management kept dormant till it is desired to expose them preparatory to planting. Whatever method of handling seed tubers is practiced, it is important that they shall not be weakened by premature sprouting in darkness.

Preparation of Scabby Seed for Planting. If the tubers are affected with scab, even slightly, they should be treated before planting. To kill the scab spores, soak the tubers one and one-half or two hours in one pint of formalin diluted by twenty-five or thirty gallons of water. Contained in gunny sacks or crates, they may be lowered into the preparation and after the requisite time lifted out and allowed to drain. Then spread them out to dry in the shade, after which they may be cut for planting as usual.

Cutting. In Farmers' Bulletin No. 35, Professor Duggar summarizes the results secured in a large number of experiments at many stations as to the proper size of seed pieces. Some of his conclusions follow:

"Experiments indicate that it is more important to cut the tubers into compact pieces of nearly uniform size than to so shape the pieces as to have a definite number of eyes on each set. No piece should be entirely devoid of eyes.

"The total yield increases with every increase in the size of seed pieces from the single eye to the whole potato. This increase occurs both in the large and in the small potatoes, but chiefly in the latter.

"The *gross yield* of *salable* potatoes (large and medium) also increases with the size of seed piece from one eye to the whole potato.

"The *net yield* of *salable* potatoes (found by subtracting the amount of seed potatoes planted and the yield of small potatoes from the total yield) increases with every increase in the size of seed piece from one eye to the half potato. The half potato affords a larger *net salable* crop than the whole potato on account of the excessive amount of seed required in planting entire tubers. Taking the average of many experiments, it was found that for every 100 bushels of net salable crop grown from single eyes there were 114 bushels from 2-eye pieces, 131 bushels from quarters, and 139 bushels from halves, but only 129 bushels from planting whole potatoes.

"These results favor the use of halves as seed pieces if seed potatoes and crop are assumed to be of equal value per bushel, but when seed potatoes command a very high price quarters may be used to advantage."

Basing our practice upon these conclusions and upon general experience, it has been the custom at this Station to use good sized tubers for planting and to cut them to three or four-ounce pieces. The number of eyes on each piece has not received much attention. There are always enough. These pieces are larger than most farmers plant, and in 1902, when making a test of potato planters, it was found that they were too large to pass readily into the pockets of the dropping apparatus of the Robbins Planter. To determine whether smaller seeds would produce equally satisfactory results, plats were planted in two parts of the field with seed pieces of one-half the size of those used on adjoining areas. These smaller pieces were still as large as many farmers recommend. The result was a decrease in yield where the smaller pieces were planted of 21.7 per cent in one case and of 41.5 per cent in the other. In that part of the field where the conditions were least favorable for the crop, the reduction in yield from the use of smaller pieces of seed was most marked, but in either case the loss exceeded the saving in seed several times over.

Cut potatoes if stored in bulk will heat and their germinating qualities will be injured; or if spread out to the air they dry up and the vigor of growth is lessened. It is, therefore, unwise to cut a large quantity of potatoes much in advance of the anticipated planting, as an untimely rain may delay the planting for days or weeks, much to the injury of the seed. Dusting the seed with land plaster or gypsum as they are cut lessens the liability to injury if not planted at once.

Several experimenters have reported increased yields resulting from treating the cut seed with plaster irrespective of any delay in planting. In 1903 the following data bearing on this point was obtained at this Station. The tubers were cut one or two days before planting and well dusted with plaster, except enough seed which was not treated of each of several varieties to plant one row across the field. The results computed to bushels per acre were as follows:

	With plaster.	No plaster.	Gain or loss.
Bovee	246.12	223.09	+23.03
Irish Cobbler	174.78	182.40	— 7.62
Doe's Pride	321.46	315.81	+ 5.65
Green Mountain (late planted)	137.87	174.56	+13.31
Doe's Pride (late planted)	211.56	185.38	+26.18

In three of the five tests, there was a substantial gain when the seed was dusted with plaster. In two cases there was no considerable effect produced. This treatment is so simple and inexpensive and the results of experiments so favorable, that its more general adoption in practice would seem to be commendable.

Planting. Because of the tillage value of a thorough stirring of the soil at planting time, the method of doing the planting in our experimental work has been described in part on p. 431 under "Preparation of the seed-bed." It is not expected or advised that farmers shall undertake to do the work in just the way we have done, but they endeavor to secure the same conditions we have secured: viz., the placing of the seed pieces well down in a thoroughly mellowed seed-bed.

As already stated, the tubers are borne on underground branches that spring out from joints that form on the main stems between the sets and the surface of the ground. Manifestly, then, there should be considerable distance between the point where the stem starts from the seed pieces and the surface of the ground in order that there may be abundant opportunity to form joints and throw out tuber-bearing branches. The general practice of farmers is not to plant deep enough to secure best results. What constitutes desirable depth depends upon circumstances, chiefly the character and condition of the soil. The lighter the soil and the more mellow the condition secured in its preparation, the deeper may the seed tubers be planted in it. If the soil is heavy and likely to settle compactly over the sets if a rain occurs, then the planting must be more shallow lest the exclusion of air and the difficulty experienced by the young plants in reaching the surface weaken their vitality. In our porous soil no disadvantage seems to result from burying the seed pieces deeply under ridges of earth, while the benefits of the deep and thorough stirring of the soil at this latest opportunity and the advantage of having these ridges to work down shortly before the plants come up, thus securing a perfectly clean mellow surface, are very important. In porous soils, the seed pieces should be found four or five inches below the surface after the leveling is completed. This really is much deeper than it seems. Many farmers suppose they are planting three or four inches deep, when in fact the sets are not two inches below the surface.

With the potato planting machines now on the market, it is difficult to plant as deep as is desirable for best results. Neither the furrow openers nor the covering apparatus are as large and effective as they should be. Manufacturers state that if they construct the machines so as to handle more earth in opening and closing the furrows, the draft will be increased and farmers will object. Of course the draft will be increased because more and better work is being done, but the farmer should willingly supply the team power to do it.

It is also objected that deep planting makes harvesting more difficult on account of the greater depth at which the tubers occur. This is true and will be a valid objection to deep planting till diggers are produced that will do thoroughly satisfactory work in potatoes lying at the greater depth.

Amount of Seed. The amount of seed required to plant an acre will necessarily vary with the size of the seed pieces, the distance between the rows and the distance between sets in the row. The distance between rows is usually determined by convenience of cultivation rather than by the largest possible yield. About three feet is accepted by most growers as a suitable distance, as it is well adapted to horse tillage. In some instances, four or six inches additional have been found to enable the horse culture to be continued later in the season and the increased yield per row has made up for the less number of rows grown. On the other hand, when land is dear and labor cheap, it is found that by lessening the distance between rows and bestowing hand labor after the horse implements are excluded by the growth of the tops, the yield per acre may be very materially increased. Distance between rows is largely a question of land vs. labor.

As to distance between sets in the rows, there is not much accurate experimental data, though there is a very generally accepted opinion that if labor is dear and land cheap, and especially if the land be badly infested with weeds, the planting may well be in check-rows so as to allow horse culture both ways. Thus is secured a somewhat lessened yield per acre but sometimes at a lessened cost of production per bushel. If, however, the land has been well cleaned and well fitted, the sets may be placed closer in the rows so that culture can be given only in one direction and larger yields per acre secured. If rows are widened so as to facilitate late tillage, the sets may be crowded closer in the rows. In practice it is found that with the rows three feet apart the sets may well be placed at 14 to 18 inches apart, depending somewhat upon the variety; and with tubers cut to about two-ounce pieces it will require from 18 to 26 bushels to plant an acre. If planted in check-rows, three feet apart each way and two ounces of seed per hill, ten bushels will plant an acre.

Harrowing the Crop. Except when the object was to test potato planting machines, the planting here has been done in the manner described on page 433, which leaves the earth thrown up in ridges over the rows. About ten days after the planting the field is harrowed with a spike-tooth harrow. Usually a scantling is placed under the front of the harrow to act as a scraper to help to level down the ridges. A second and sometimes a third harrowing is given before the plants appear above ground. By this means the land is nearly leveled, the clods and stones, if any, are pulled off the rows into the spaces between, several crops of young weeds are destroyed and the young potato plants are soon established in a thoroughly clean, mellow soil.

Cultivating. As soon as the rows can be readily followed, the cultivators should be started. Sometimes we have been able to use the weeder at this time to good advantage, but more frequently not. If rain has fallen since the last harrowing, a crust is usually formed on our soil which is too hard for a weeder to break up. If the surface is free from crust, the weeder does excellent and rapid work, only care must be taken not to use it just as the plants are coming through the surface, as at this time they are very tender and easily broken. After a few days exposure to light and air they become toughened and will not be much injured by the weeder.

If the weeder cannot be successfully used for the first cultivation and especially if young weeds are beginning to start in the rows, a very close, shallow cultivation should be given as soon as possible. This cultivation should be shallow because it cannot be deep and equally close without danger of injury to the young plants. The next cultivation should be as deep as it is practicable to make the cultivator go, keeping away from the rows far enough not to endanger the young plants. The object should be to make the soil between the rows as mellow and as deep as possible. This deep cultivation should follow soon after the close shallow one, or if the weeder was successfully used after the crop was up and the rows are free from weeds, it may take the place of the latter.

In all of our tillage experiments with potatoes, the preparation of the soil, the planting and the treatment up to the second cultivation have been practically as already described. The variations in treatment accorded to the different plats have begun at this point and have consisted, in the main, of comparisons of different numbers of cultivations, of level tillage vs. hilling, and of tests of Bordeaux mixture to prevent blight. The following data are reproduced from Bulletins 140, 156 and 196 and are arranged so as to present only one phase of the work at a time. The grouping indicates plats that are strictly comparable, as they were treated exactly alike except as indicated in the third column:

TABLE III.—SHOWING THE EFFECT OF NUMBER OF CULTURES.

YEAR.	Plat.	Number of cultures.	Yield per acre.	Gain.
			Bushels.	*Bushels.*
1895	Plat No. 21	13	378	
	Plat No. 22	9	415	
	Plat No. 23	13	319	
	Plat No. 24	9	414	
	Plat No. 25	13	304	
	Plat No. 26	9	311	
	Plat No. 27	13	350	
	Plat No. 28	9	330	
	Average, 4 plats	13	337½	
	Average, 4 plats	9	367½	30
1896	Plat No. 8	7	350.3	70.3
	Plat No. 9	11	338.1	58.1
	Plat No. 10	3	280	
	Plat No. 11	3	299.7	
	Plat No. 12	7	341.6	41.9
	Plat No. 31	7	346.5	100.6
	Plat No. 32	11	339.	93.2
	Plat No. 33	3	245.8	
	Average, 3 plats	7	346.1	70.9
	Average, 2 plats	11	335.7	60.5
	Average, 3 plats	3	275.2	
1897	Plat No. 35	8	357	8
	Plat No. 36	5	349	
	Plat No. 40	5	305	
	Plat No. 41	7	347	42
1898	Plat No. 22	6	344.8	41.5
	Plat No. 23	3	303.3	
	Plat No. 26	6	310.5	40.9
	Plat No. 27	3	269.6	
			28	
1899	Plat No. 37	3	188	
	Plat No. 38	6	169	—19
	Plat No. 39	9	174	—14
	Plat No. 41	3	195	
	Plat No. 42	6	213	18
	Plat No. 43	9	241	46
1900	Plat No. 23	5	98	5
	Plat No. 24	3	93	
	Plat No. 38	5	129	13
	Plat No. 39	4	124	8
	Plat No. 40	3	116	
	Plat No. 41	4	147	31

It will be observed that seven to nine cultivations gave better than a greater or lesser number. Above that number the injury to the plants more than counterbalanced any improved condition of the soil.

The falling off of the yields for 1899 and 1900 is due to several causes. Droughts occurred each season. In 1899 the rainfall at Ithaca from April to October was 6.31 inches and in 1900 10.06 inches less than normal, while the temperature was above normal every month except September, 1899, and May, 1900. These plats had been under intensive cultivation since 1894 without manure, and the amount of humus in the soil was becoming reduced so that the effect of the drought was markedly manifested.

Hilling vs. Level Culture. From the beginning of these experiments it was the practice not to hill the potatoes, believing that level tillage was more rational; but as many farmers persist in urging that hilling is desirable, some plats were given this treatment and the following table gives results:

Table IV.—Showing Yields of Plats Given Level Culture Compared with Hilling at Last Culture.

YEAR.	Plat.	Treatment.	Yield per acre, bus.	Difference bus.
1897	No. 37	5 cultures, level	325	
	No. 38	5 cultures, hilled	288	37
1898	No. 24	3 cultures, level	340	
	No. 25	3 cultures, hilled	327	13
1899	No. 40	3 cultures, hilled	194	
	No. 41	3 cultures, level	195	
1900	No. 25	3 cultures, level	104	
	No. 26	3 cultures, hilled	103	
1901	No. 8	3 cultures, level	284	
	No. 9	3 cultures, hilled	259	25
	No. 14	4 cultures, level	247	
	No. 15	4 cultures, hilled	246	
	No. 16	4 cultures, level	250	

These comparisons are all of adjoining plats cultivated the same number of times. The ordinary practice of many farmers is to "hill up" at about the third working and "lay by" the crop. A better practice would be to give several additional cultivations without hilling. Unfortunately, our experiments were so arranged that we cannot make comparisons of the two methods and have the plats adjoining, though in the following instances they were near enough to be fairly comparable:

YEAR.	Plat.	Treatment.	Yield.	Difference.
1897	No. 38	5 cultures, hilled	288	96
	No. 34	8 cultures, level	384	
1898	No. 25	3 cultures, hilled	327	18
	No. 22	6 cultures, level	345	
1899	No. 40	3 cultures, hilled	194	47
	No. 43	9 cultures, level	241	

In some instances the hilling seems to have had little effect on yield; in others a material reduction in yield seems to result.

Combating the Blight. The potato blight has now become so prevalent in New York that no potato grower can afford not to take preventive measures against it. A few years ago there was a fair chance that the crop might escape without preventive treatment. There seems to be little chance now. Fortunately, while combating the blight we may effectually control the "bugs" and the little black flea-beetles at the same time. Paris green or other poisons may be introduced into the Bordeaux mixture whenever the presence of the Colorado beetles make it necessary, and the Bordeaux mixture, while not killing the flea-beetles, repels them to such an extent that they do little damage. There is considerable evidence that aside from their effect in holding in check these enemies of the potato crop, Bordeaux mixture and Paris green when properly applied exert a tonic effect upon the plants. That is, even if these enemies do not appear upon the check plats, or are destroyed by other means, the plats treated with Bordeaux mixture and Paris green produce increased yields.

The following table gives a summary of the data secured at this Station relating to the use of Bordeaux mixture for blight prevention. Some seasons no blight appeared and little effect was observed. In 1902, owing to excessive rainfall in July the work was hindered to such an extent that the whole crop became affected with blight and no data was taken:

TABLE V.—SHOWING YIELD OF PLATS NOT SPRAYED AND SPRAYED WITH BORDEAUX MIXTURE.

YEAR.	Plat.	Treatment.	Yield bus. per acre.	Difference.
1897	No. 39	Not sprayed	234	
	No. 40	Sprayed 4 times	305	+71
1898	No. 29	Sprayed 7 times	213	+7
	No. 30	Not sprayed	206	
1899	No. 35	Sprayed 6 times	192	+48
	No. 36	Not sprayed	144	
1900	No. 21	Sprayed 4 times	105	—30
	No. 22	Not sprayed	135	
	No. 23	Sprayed 4 times	98	—37
1901	No. 18	Sprayed 2 times	229	+83
	No. 19	Not sprayed	146	+83
1903	No. 5	Not sprayed	289	
	No. 6	Dry Bordeaux 3 times	323	+34
	No. 7	Sprayed 4 times	353	+64

More extended and thorough experiments than have been attempted by this Station have been conducted by the State Experiment Station at Geneva and to its reports the reader is referred for more detailed information, regarding the benefits of spraying. Bulletin No. 217 of this Station gives instructions in regard to making and use of Bordeaux and other spray mixtures.

Varieties. Every farmer knows that the question of varieties is an important one. It is not uncommon for one of two varieties planted in the same field to outyield the other two to one. Owing to the rapid degeneration or "running out" of varieties as they are ordinarily managed, the testing and reporting upon varieties of potatoes is very unsatisfactory and unattractive work for experiment stations, as the value of the data obtained is only temporary (the varieties changing in vigor so quickly) and often of only local application, as different varieties are adapted to certain soils and localities in different degrees. The test of varieties is an experiment that should and does appeal strongly to the individual potato grower. The results obtained upon his own soil are more valuable to him than those obtained elsewhere and more valuable to him than to anybody else. Keeping posted on varieties is much like keeping posted in regard to market prices.

To assist farmers along this line, for several seasons past the College of Agriculture has included variety test of potatoes in its list of extension experiments. Five pounds of each of several selected varieties of potatoes have been sent to farmers for test. They are requested to plant them on uniform areas, give uniform treatment, harvest and weigh the product and report results to the College. The following tables give some of the results secured in 1903 and 1904. A study of the tables reveals the fact that nearly every variety will take first rank in some instances and last in others, but that some are much more likely than others to head the list; also that some varieties seem to be much more affected by the character of soil than others. The rank assigned does not always follow yield, but the preference for varieties as expressed by the farmer after taking all characteristics into consideration. These are all varieties that were highly recommended at the time they were tested:

TABLE VI.—SHOWING RESULTS OBTAINED WITH THREE VARIETIES OF LATE POTATOES GROWN SIDE BY SIDE ON 17 DIFFERENT FARMS IN 1903.

NAME.	County.	Soil.	Doe's Pride.		Green Mountain.		Sir Walter Raleigh.	
			Lbs. per plat.	Rank.	Lbs. per plat.	Rank.	Lbs. per plat.	Rank.
Hubbs Bros.	Madison	L	123	1	117	2	103	3
Manley Clark	Otsego	L	127	1	117	2	111	3
John R. Ennis	Chemung	L	30	3	49	2	52	1
Roy Lapham	Wyoming	L	127	2	142	1	89	3
Harry T. Field	Madison	L	78	3	121	1	87	2
E. T. Brizze	Ontario	L	106	3	165	1	116	2
J. L. Stone	Tompkins	M	123	1	95	2	76	3
Wm. A. Irwin	Jefferson	M	85	1	66	2	65	3
C. E. J. McMahon	Chenango	M	90	1	82	2	58	3
Edw. W. Wheat	Delaware	M	79	2	86	1	42	3
C. W. Driggs	Genesee	M	79	2	77	3	99	1
Robert Lee	Oneida	M	106	1	99	2	76	3
W. F. Menthew	St. Law	M	150	1	125	2	88	3
Perry Cooper	Erie	M	56	1	55	2	37	3
Frank E. Richardson	Chaut	M	115	1	52	3	88	2
Alexis York	Madison	M	65	1	64	2	42	3
M. J. Upton	Oswego	M	115	1	52	3	88	2
Av. lbs. per $\frac{1}{200}$ acre plat			96.12	......	92	......	77.47	......
Av. bu. per acre			320.4	......	306.66	......	258.23	......
No. times took 1st rank			11	......	4	......	2	......
No. times took 2d rank			3	......	10	......	4	......
No. times took 3d rank			3	......	3	......	11	......
Av. bus. per acre on 6 light soils			328.30	......	328.30	......	310	......
Av. bus. per acre on 11 medium soils			316.06	......	265.43	......	230	......
Difference in yield on light and medium soils			12.24	......	62.87	......	80	......

TABLE VII.—TABLE SHOWING RESULTS OBTAINED WITH TWO VARIETIES OF EARLY POTATOES GROWN SIDE BY SIDE ON SEVEN DIFFERENT FARMS IN 1903.

NAME.	County.	Soil.	Bovee.		Irish Cobbler.	
			Lbs. per plat.	Rank.	Lbs. per plat.	Rank.
S. M. Jones	Jefferson	L	70	1	24	2
George A. Kirkland	Chautauqua	L	87	1	57	2
J. R. Dillin	Jefferson	L	58	1	51	2
C. G. French	Oneida	L	94	1	58	2
J. L. Stone	Tompkins	M	42	1	41	2
H. F. Horton	Rensselaer	M	77	1	63	2
Frank H. McLaury	Delaware	M	52	1	31	2
Average lbs. per plat			68.56	......	46.4	......
Average bus. per acre			228.56	......	154.66	......
Average bus. per acre on 4 light soils			257.50	......	158.33	......
Average bus. per acre on 3 medium soils			190.00	......	150.00	......
Difference in yield on light and medium soils			47.50	......	8.33	......

TABLE VIII.—SHOWING RESULTS OBTAINED WITH THREE VARIETIES OF POTATOES WHEN GROWN SIDE BY SIDE ON TWENTY-SEVEN DIFFERENT FARMS IN 1904.

NAME.	County.	Soil.	Gold Coin.		Wilson's 1st choice.		Prosperity.	
			Lbs. per plat.	Rank.	Lbs. per plat.	Rank.	Lbs. per plat.	Rank.
W. A. Prentice	Livingston	L	131	1	117	3	120	2
Frank Paddock	Wyoming	L	50	3	62	1	51	2
Earle Morse	Wyoming	L	46	2	64	1	44	3
W. W. Salmon	Lewis	L	158	1	112	2	101	3
L. P. Frisbee	Delaware	L	42	2	49	1	36	3
W. C. Buell	Ontario	L	80	1	67	3	77	2
F. A. Salisbury	Ontario	L	86	2	94	1	79	3
M. L. Peryer	Clinton	L	124	1	104	2	101	3
C. H. O. Reiner	Suffolk	L	22	2	25	1	14	3
E. A. Lloyd	Niagara	L	60	3	81	1	66	2
P. S. Birch	Tompkins	L	152	1	143	2	128	3
S. L. Shapley	Madison	L	66	2	77	1	64	3
C. T. Stone	Madison	L	37	3	71	1	51	2
J. Zelie	Schuyler	L	101	3	87	2	105	1
Wm. Lowey	Orange	L	88	1	66	2	64	3
George A. Petri	Sullivan	H	87	3	94	2	101	1
George A. Goodwin	Cayuga	H	52	......	....	......	56	......
Perry Cooper	Erie	H	41	1	15	3	28	2
H. Post	Erie	H	43	1	40	3	42	2
Jarvis Bros	Otsego	H	93	2	95	1	85	3
E. L. Wellman	Chaut	H	34	2	39	1	30	3
C. C. Brayman	Albany	H	108	3	144	1	119	2
G. C. Bogart	Tioga	H	30	1	29	2	26	3
Ray B. Bower	Onondaga	H	128	1	114	3	117	2
H. D. Gage	Chenango	H	118	1	118	3	136	2
G. W. Tailby	Tompkins	H	47	2	49	3	51	1
A. E. Patrick	Chenango	H	74	1	72	2	65	3
Average lbs. per plat			77.7	......	78.0	......	72.5	......
Average bus. per acre			259.0	......	260.0	......	241.6	......
Average on 15 light soils			276.3	......	271.0	......	244.6	......
Average on 12 heavy soils			237.7	......	245.0	......	237.7	......
Difference in yield on light and heavy soils			38.6	......	26.	......	6.9	......
No. of times took 1st rank			12.	......	11.	......	3.	......
No. of times took 2d rank			8.	......	8.	......	10.	......
No, of times took 3rd rank			6.	......	7.	......	13.	......

Potato Machinery. The College of Agriculture has at various times made trials of planters, cultivators and diggers. These trials have not, however, been sufficiently extended or included a sufficient number of machines to warrant a report in detail, but some general considerations growing out of our tests and observations may be given.

A number of planters have been tested and in comparison with the old method of hand planting most of them work successfully. They do the work rapidly and largely reduce the expense of planting. But each of them leaves something more to be desired. With those machines having automatic droppers, we failed to secure as regular and even placing of the seed as is necessary for the largest yields. About 80 per cent correct was the result usually secured. The other 20 per cent was either misses or the seed was not deposited at the proper place. Those machines requiring an attendant to supervise the dropping did more accurate work. In fact, with a quick, faithful attendant the placing of the seed can be made nearly or quite 100 per cent correct.

None of the machines handled earth enough in the planting operation to satisfy those conducting the test. The seed is not placed as deep in the soil as it should be and the soil is not loosened about the seed as it should be. The opening apparatus on some machines simply presses the soil aside and compacts it instead of raising and loosening it after the manner of a plow. Again, the covering apparatus does not work deep enough nor ridge the earth up over the row sufficiently for best results in light mellow soils. Perhaps in soils with considerable clay they cover sufficiently. Notwithstanding these shortcomings, the planters are indispensable if considerable areas of potatoes are to be grown, and do better work than is usually secured by hand planting.

Wheel cultivators of various patterns are now so well known and widely used as scarcely to need mention here. For use in the potato field while the plants are small, they greatly excel the small cultivators both as to qualtity and rapidity of work. When the vines get large, however, the small cultivators must be used to maintain the mulch between the rows. They should have a wheel in front and a runner or guard at the rear to keep the blades from cutting deep enough to injure the roots growing between the rows.

Potato diggers are not as satisfactorily developed as are the planters. If the attempt is to raise the potatoes, separate them from the soil and lay them on the surface in convenient shape for picking up, digging is a much more difficult undertaking than planting. Several machines accomplish this feat in a satisfactory manner in mellow soils free from stones and unencumbered with weeds. The machines that do not undertake to do so complete work can be used to fair advantage where the former class utterly fails. One digger that is little more than a heavy, strong double mould-board plow with tines or prongs at the rear to help to separate the potatoes from the soil has proved with us very helpful in harvesting the crop under conditions where the more complicated tools were useless. As in the case of planters, however, the grower of any considerable area of potatoes can no longer afford not to use a digger if he can find one that will do satisfactory work in his soil. A farmer whose operations we have closely followed, has within a few years introduced into his potato growing a planter, wheel cultivator and digger and states that he can now produce fôur acres of potatoes with the labor and expense formerly expended upon one acre and secure even better results than formerly.

J. L. STONE.

OUTLINE OF CO-OPERATIVE DEMONSTRATIONS TO BE MADE IN 1905.

The following schedule gives a list of the demonstrations or experiments that it is proposed to make with New York farmers in the season of 1905. These experiments cover some of the most important of the newer problems that are just now pressing themselves on the attention of our farmers. The list contains enough subjects to offer to every farmer one or two for his particular study. We desire to correspond with any person in the state who may wish to take up any one or more of these subjects on his own place. If there are other important problems pressing for solution in any locality, we should be glad to consider them; but in order to make the work efficient, it is necessary to limit our endeavors.

There are three purposes in this extension experiment work: (1) To illustrate or teach,—to instruct the co-operator in methods, to set him at the working out of his own problems, to bring him into touch with the latest discoveries and points of view. (2) To demonstrate in various parts of the State the value or the inefficiency of various new theories and discoveries,—to determine how far these newer ideas are applicable to local conditions. (3) To discover new truth, which may be worthy of record in bulletins: this is usually the least of the results that follow from such experiments because the experiments are not under perfect control nor continuously under the eye of a trained observer.

These 48 demonstrations and experiments are in seven categories, each category in charge of a specialist: I. Agronomy, J. L. Stone; II. Plant Selection and Breeding, J. W. Gilmore; III. Horticulture, John Craig; IV. Entomology, M. V. Slingerland; V. Animal Husbandry, H. H. Wing; VI. Poultry Husbandry, J. E. Rice; VII. Dairy Industry, R. A. Pearson. Correspondence should be addressed to the persons who have charge of these branches at Cornell University, Ithaca, N. Y. Specify by number the experiments in which you are interested.

The general plan of work is mutual or co-operative—the farmer to provide land and labor and to have the crop, the expert to give advice and supervision and, so far as possible, to inspect the work. In some cases the college furnishes seeds and other materials. It does not furnish fertilizers. The benefit of the experiment or demonstration is expected to accrue mostly to the person on whose place the work is done.

It will be impossible, of course, to serve anyone. We shall take only as many experiments as we think we can handle satisfactorily. Persons who desire to engage in this work must apply quickly. Full instructions, together with blanks for the making of reports, will be sent to applicants.

I. AGRONOMY OR FIELD CROPS.

(J. L. STONE.)

No. 1. *Alfalfa.* (a) The experimenter to report the conditions existing, the manner of treating the crop and the successes and the failures met in his experience. The direct experiments suggested are;

(b) Seeding with and without a nurse crop;

(c) Treating a portion of the area with lime;

(d) When nodules are not found on the alfalfa roots, obtain some infected soil from a field where nodules are abundantly produced and scatter it over a portion of the area;

(e) Apply stable manure to a part of the inoculated area and also to an uninoculated plat.

No. 2. *Oats.* A test of three varieties of oats from selected seed. Seed of each variety sufficient for a plat one rod by two rods will be sent to the experimenter. Weight of total crop and of grain to be determined in each case.

No. 3. *Fertilizers.* A test with nitrogen, phosphoric acid and potash singly and in combination, eight plats 1–20 to 1–10 acre each. The set comprises 260 lbs. of chemicals that cost the experimenter four dollars.

No. 4. *Potatoes.* (a) Test of varieties. Five pounds of each of three selected varieties will be furnished by the college. To be planted on a definite area and crop weighed.

(b) Cultural experiment. A comparison of the Cornell method with your own as described in Circular No. 18.

No. 5. *Sunflower* in corn for silage. Seed will be furnished for a test.

No. 6. *Soy beans.* A test of several varieties with a view to determine

(a) Their grain producing qualities,

(b) Their forage producing qualities,

(c) Their green manurial qualities,

(d) Adaptation to growing with corn to improve the quality of silage.

(e) Is artificial inoculation necessary?

(Experiments at the Cornell station indicate that this desirable natural stock food may be grown to advantage in New York.)

No. 7. *Field beans.* A test of several leading sorts. About one pint of seed of each variety furnished by the College.

No. 8. *Buckwheat.* (a) Variety test. Seed of each variety sufficient for a plat one rod by two rods will be sent to the experimenter. Weight of total crop and of grain to be determined in each case.

(b) Cultural experiment. Plow one plat early and harrow frequently till seeding time. Plow another plat just before seeding.

No. 9. *Winter vetch and rye.* A test of the combination as a cover-crop, which may be used as a soil renovator, as early spring pasture, as a forage crop or for the production of seed.

No. 10. The destruction of certain weeds such as wild mustard, alfalfa, dodder, devil's paint brush, wild carrot, rag weed, smartweed, etc., by spraying with chemical solutions.

No. 11. *Testing the effect of lime on soils.*

No. 12. *The inoculation of legumes by means of artificial culture.*

No. 13. *The renovation of pastures and meadows without plowing.*

No. 14. *Dwarf milo.* Sufficient seed of this new forage and grain plant will be sent for a test. Fuller description and instruction with seed.

No. 15. *Rotation Experiment. Legumes vs. Non-legumes.* This experiment should extend through several seasons.

II. Plant Selection and Breeding.

(J. W. Gilmore.)

No. 20. *Potatoes.* An experiment in selection for the purpose of increasing the yield.

No. 21. *Potatoes.* An experiment to determine the effect of different soils in different localities upon the yield and quality.

No. 22. *Oats.* An experiment in selection for the purpose of increasing the yield.

No. 23. *Wheat.* An experiment in selection for the purpose of increasing the yield. (To be begun in the fall.)

III. Horticulture.

(John Craig.)

No. 30. *Orchard cover-crops.* 3 plats. A comparison of the values of hairy vetch, cow peas and mammoth clover, in apple, plum, pear or peach orchard. All plats in cover-crop experiments $\frac{1}{8}$ acre in extent. Keep soil thoroughly stirred from spring until middle of July, when seed should be sown. Seed furnished by the College. Study also the influence on temperature of soil. Record temperatures daily at noon in cover-cropped soil and in soil without cover.

No. 31. *Mulching vs. cover cropping.* We want half a dozen volunteers to undertake a serious comparison of these two methods of managing orchard soil. We would like to include at least apples and pears in the experiments; other fruits if possible. We should like to include in the range of the experiments different types of soil. Therefore a wide representation is desired. Particulars sent on application.

No. 32. *Spraying experiment.* Compare lime and sulphur with Bordeaux mixture as a fungicide. Prepare according to directions given in Spray Calendar.

No. 33. *Dust spray vs. Bordeaux mixture.* (A limited number of experiments.)

No. 34. *Spraying to prevent peach and plum rot.* Ammoniacal copper carbonate. Spray twice as fruit is ripening. Spraying material furnished by the College.

No. 35. *Thinning fruit.* Conduct careful tests on early apples peaches and plums.

No. 36. *Strawberry.* Variety test.

No. 37. *Raspberry.* Variety test.

Experimenters are requested to send the Department of Horticulture descriptions of new varieties of fruits; samples of fruit will also be gladly received and examined.

IV. ENTOMOLOGY.

(M. V. SLINGERLAND.)

No. 41. *Poison sprays for plum and quince curculios.* Experiments with arsenate of lead and arsenate of lime sprays. Specific directions and arsenate of lead furnished by the College.

No. 42. *Spraying for grape root-worm.* Experiments with arsenate of lead spray to poison the beetles. Specific directions as given in Bulletin 208 or the Spray Calendar. (Bul. 217.)

No. 43. *Spraying and timely cultivation for the rose-chafer.* Specific advice in regard to time to cultivate to kill the pupæ, and directions given for spraying with arsenate of lead to kill the beetles. Poison furnished by the College.

V. ANIMAL HUSBANDRY.

(H. H. WING.)

No. 50. *Cattle.* The information sought will include (a) period of gestation of cows, (b) sex of offspring, (c) weight of offspring, at birth, (d) in case where calves are raised or vealed weight at four, six and eight weeks of age. To those who undertake this work cards for making reports will be furnished on request.

No. 51. *Swine.* The information asked for will include (a) period of gestation, (b) number of offspring, (c) sex of offspring, (d) weight of litter and if possible of each individual at birth. To those who undertake this work, cards for making reports will be furnished on request.

VI. POULTRY HUSBANDRY.

(J. E. RICE.)

No. 60. *Importance of supplying grit to fowls* to determine the amount consumed, the best kind, and the effect upon the quantity of eggs, hardness of shell, and in preventing "egg eating."

No. 61. *The importance of meat in a ration for egg-production,* and to observe the effects upon number, size and fertility of eggs and vitality of chickens.

No. 62. *The value of a ration of whole grain* as compared to the same ration part ground and fed dry or fed in a "hot mash."

No. 63. *Comparative value of hot mash* and the same feed fed dry.

No. 64. *Breed test.* A comparison of pens of the same number of individuals of different varieties of similar age.

No. 65. *Study of poultry houses.* To determine temperatures inside and out, also dampness, and to observe comparative value of different types and styles of construction. For example, with and without hooded roosts. With and without curtains in front of windows; with and without double walls or gables stuffed with straw. With and without various kinds of ventilators, cloth windows or glass windows, etc., etc.

No. 66. *Feeding chickens whole grain vs. soft food,* or rations with and without some form of meat or skimmed milk.

No. 67. *Trap nest records* of each hen in the flock. (Plans for trap will be furnished free.)

No. 68. Weigh all the feed which a flock of fowls consume during one or more weeks. Keep a record of the eggs laid each day and the age, variety and number of hens in the flock. Send report on blanks which we will furnish on application and if it is desired we will figure the nutritive ratio and cost of the ration, and will suggest changes if necessary.

No. 69. Send measurements of poultry houses, giving length, breadth, height to plate and ridge. Figure the square feet of floor space, cubic feet of air space, square feet of window opening; number and kind of fowls enclosed. Draw end view, front view, ground plan and show construction of walls, kind of roof, straw loft, etc.

VII. DAIRY INDUSTRY.

(R. A. PEARSON.)

No. 80. *Churning.* Complaint is often heard about the difficulty of churning cream from the milk of a cow far advanced in the period of lactation; sometimes it is said such cream cannot be churned.

Churn separately the cream from "stripper" milk in the usual manner. Carefully note length of time of churning, and temperature 18 or 12 hours, five hours, one hour, and five minutes before churning.

As soon as practicable, churn another lot of similar cream, but make sure that it is well ripened at 70° F. and held at 62° F. at least five hours before churning and churn it at 62°. Compare results with previous churning. Determine in succeeding churnings the advantages and disadvantages of higher and lower temperatures for ripening and churning.

No. 81. *Small-top Milk Pails.* To determine how much, if any, their use increases the time or labor of milking.

No. 82. *Period of Ripening.* A comparison of long and short periods of cream ripening—large starter and short period, small starter and long period, and large starter and long period.

No. 83. *Washing Cream.* The effect of this treatment upon flavor and grain of the butter.

No. 84. *Whey Butter.* Methods of making butter from the milk-fat lost in cheese making.

No. 85. "To determine the cost in labor, or cash outlay, necessary to improve the sanitary condition of a dairy as shown by a score card which will be furnished upon application."

The Following Bulletins are Available for Distribution to Those Residents of New York State Who May Desire Them.

72 The Cultivation of Orchards, 22 pp.
119 Texture of the Soil. 8 pp.
121 Suggestions for Planting Shrubbery.
126 The Currant-Stem Girdler and the Raspberry-Cane Maggot, 22 pp.
129 How to Conduct Field Experiments with Fertilizers, 11 pp.
134 Strawberries under Glass, 10 pp.
135 Forage Crops, 28 pp.
136 Chrysanthemums, 24 pp.
137 Agricultural Extension Work, sketch of its Origin and Progress, 11 pp.
138 Studies and Illustrations of Mushrooms; I. 32 pp.
139 Third Report upon Japanese Plums, 16 pp.
140 Second Report upon Potato Culture, 24 pp.
141 Powdered Soap as a Cause of Death Among Swill-Fed Hogs.
142 The Codling Moth.
143 Sugar Beet Investigations, 88 pp.
144 Suggestions on Spraying and on the San José Scale.
145 Some Important Pear Diseases.
146 Fourth Report of Progress on Extension Work, 26 pp.
147 Fourth Report upon Chrysanthemums, 36 pp.
148 Quince Curculio, 26 pp.
149 Some Spraying Mixtures.
150 Tuberculosis in Cattle and its Control.
151 Gravity or Dilution Separators.
152 Studies in Milk Secretion.
153 Impressions of Fruit-Growing Industries.
154 Table for Computing Rations for Farm Animals.
155 Second Report on the San José Scale.
157 Grape-vine Flea-Beetle.
158 Source of Gas and Taint Producing Bacteria in Cheese Curd.
159 An Effort to Help the Farmer.
160 Hints on Rural School Grounds.
161 Annual Flowers.
162 The Period of Gestation in Cows.
163 Three Important Fungous Diseases of the Sugar Beet.
164 Peach Leaf-Curl.
165 Ropiness in Milk and Cream.
166 Sugar Beet Investigations for 1898.
167 The Construction of the Stave Silo.
168 Studies and Illustrations of Mushrooms; II.
169 Studies in Milk Secretion.
170 Tent Caterpillars.
171 Concerning Patents on Gravity or Dilution Separators.
172 The Cherry Fruit-Fly: A New Cherry Pest.
173 The Relation of Food to Milk Fat.
176 The Peach-Tree Borer.
177 Spraying Notes.
178 The Invasion of the Udder by Bacteria.
179 Field Experiments with Fertilizers.
180 The Prevention of Peach-Leaf Curl.
181 Pollination in Orchards.
182 Sugar Beet Investigations for 1899.
183 Sugar Beet Pulp as a Food for Cows.
184 The Grape-Root Worm; New Grape Pest in New York.
185 The Common European Praying Mantis; A New Beneficial Insect in America.
186 The Sterile Fungous Rhizoctonia.
187 The Palmer Worm.
188 Spray Calendar.
189 Oswego Strawberries.
190 Three Unusual Strawberry Pests and a Greenhouse Pest.
191 Tillage Experiments with Potatoes.
192 Further Experiments against the Peach-Tree Borer.
193 Shade Trees and Timber Destroying Fungi.
194 The Hessian Fly. Its Ravages in New York in 1901.
195 Further Observations upon the Ropiness in Milk and Cream.
196 Fourth Report on Potato Culture.
198 Orchard Cover-Crops.
199 Separator Skimmed Milk as Food for Pigs.
200 Muskmelons.
201 Buying and Using Commercial Fertilizers.
205 Shade Trees.
206 Sixth Report of Extension Work.
207 Pink Rot an Attendant of Apple Scab.
208 The Grape Root-Worm.
209 Distinctive Characteristics of the Species of the Genus Lecanium.
210 Commercial Bean Growing in New York.
211 Co-operative Poultry Experiments. The Yearly Record of Three Flocks.
212 Cost of Producing Eggs. Second Report.
215 The Grape-Leaf Hopper.
216 Spraying for Wild Mustard and the Dust Spray.
217 Spray Calendar.
218 Onion Blight.
219 Diseases of Ginseng.
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ITHACA, N. Y.

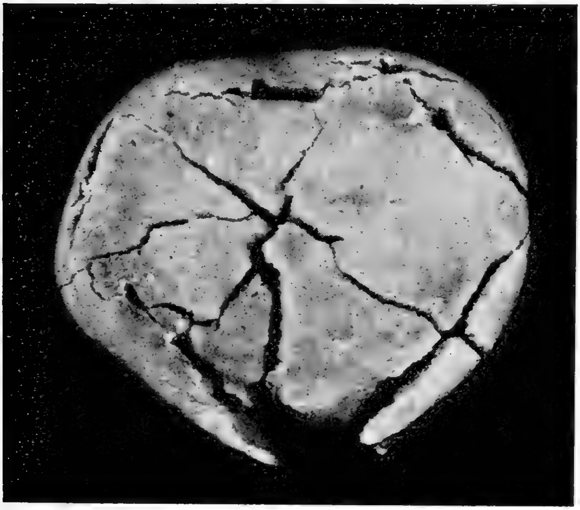
June, 1905 BULLETIN 230

CORNELL UNIVERSITY

AGRICULTURAL EXPERIMENT STATION OF THE COLLEGE OF AGRICULTURE

Department of Agronomy

QUALITY IN POTATOES.



By JOHN W. GILMORE.

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A STUDY OF QUALITY IN POTATOES.

Present Estimates of Quality.

The chemists have given no little attention to the study of potatoes both as a human and as an animal food product. Recognizing that the food value of potatoes is almost entirely dependent upon their starch content, extensive analyses have been made to determine the amount of starch in the potato and its proportion to other substances and to water. The protein, starch and fat content and the presence of other substances which influence flavor and color, have been investigated. These studies have been of great value to the potato interests, for they have not only shaped and added to our knowledge of the potato tuber as a plant organ, but they have stimulated efforts to improve the plant to the end that it may yield more abundantly and give a more acceptable product for human food. From both of these points of view great advances have been made, for the potatoes of colonial times gave poor yields and were not so acceptable for food as they are now. Through the knowledge of the potato and its composition, farmers have been educated to better practices and methods of tillage, storing and marketing, considerations which have been extended to other crops.

It is upon the considerations of starch content and other chemical properties that the estimation of quality has usually been made. The standard of chemical composition is fairly adequate when only the utility of potatoes for the manufacture of starch is considered, and perhaps also when potatoes are used only for stock food. But the proportion of the country's production of potatoes for starch manufacture as compared with the quantity produced for food is very small; and, in addition to this, as a general rule, it is the unripe and unmarketable tubers which are used for starch manufacture. From the view point of the starch manufacturer, the starch content of the potato would be a good and a logical basis for estimating the quality; but of the $332\frac{3}{4}$ million bushels (332,830,300) produced in the United States in 1904, only a little more than five millions (5,166,666) were used in the manufacture of starch. As a general rule, it is only those potatoes which are worth less than fifty cents per barrel that find their way to the starch factory. The same may be said also of those used for stock food. These facts apply for conditions in this country; but in France and some other parts of Europe potatoes are grown directly for starch manufacture and for stock feeding as well as for table consumption.

It is true, however, that the starch content must be considered in any estimate of the quality of potatoes; for when this is deficient or falls below a certain standard (about 17 per cent), the indications are that the tubers have not developed properly, have not ripened, or they have grown under adverse climatic or soil conditions; and such potatoes prepared for food will not meet the standard set for table potatoes in this country. The analyses of a number of samples of four different varieties, Hebron, White Elephant, Delaware and Carman, grown in Aroostook Co., Maine, by the Maine Experiment Station, showed a variation in starch from 15.96 per cent to 20.36 per cent, most of them ranging from 18 to 19 per cent. H. W. Wiley states that although potatoes grown in Maine are less rich in starch than those grown in foreign countries, yet those grown in Maine are more palatable than those grown in Germany.* The figures in the following table include those quoted by Dr. Wiley, to substantiate his belief, along with others which bear upon this subject:

ANALYSES OF POTATOES FROM DIFFERENT SOURCES.

SOURCE.	No. of analyses.	No. of varieties.	Protein.	Starch.	Quality.
Cornell	43	4	1.899	17.356	Very good
Maine	16	4	2.17	18.037	Very good
U. S. all sources	136	....	2.2	18.4	....
France:					
Coudon and Bussard†	7	7	2.676	11.798	Very good
	8	8	2.411	13.218	Good.
	7	7	2.365	14.118	Passable.
	12	12	2.09	16.047	Poor.
Germany:					
Morgen	....	38	2.025	20.013	....
König	....	....	1.95	20.69	....
W. Wolff	....	....	2.1	20.7	....
Maercker	....	20	....	19.81	....

In studying the statement above, the fact must be taken into account that the culinary value of potatoes varies with the tastes and estimation of different persons. In the United States a tuber of a starchy flavor, white and floury in color and mealy when cooked, is considered more desirable than one which is strong, colored or soggy after boiling. This mealy condition is usually found in potatoes with a starch content ranging from 18 to 20 per cent, though

* Bul. 58, Div. of Chem., U. S. D. A.

† Annales de la Science Agronomique, 2 ser. 1397, p. 276.

such condition may not depend directly upon starch content. In France, on the other hand, we are led to believe, by observation and experience and by published data, that potatoes which retain their form, are yellowish in color, and are soggy after boiling, are most desired for culinary purposes. This condition is usually found in potatoes low in starch content and high in protein; it may be a condition which is possessed by the particular variety, or it may be due to unripeness or to unfavorable conditions for growth and development. In the preceding table may be observed some analyses by Coudon and Bussard bearing on the quality of potatoes in its relation to starch and protein content. These authors analyzed

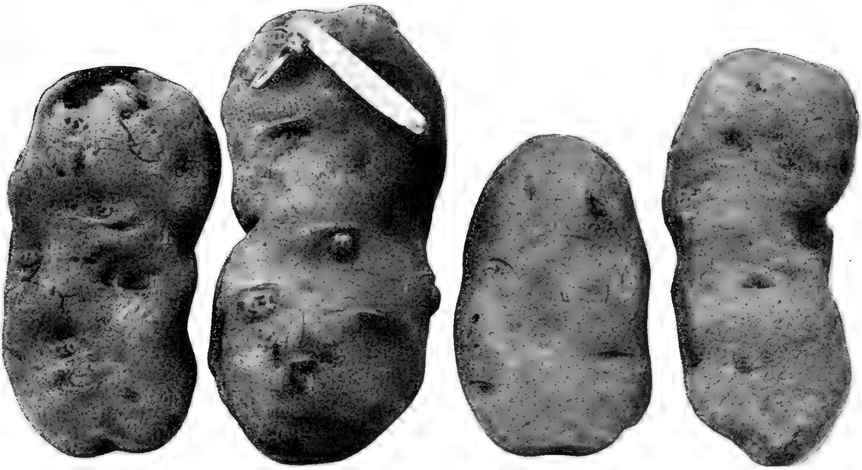

FIG. 172.—*Tubers too large for market. They may be of good quality, and are sometimes desirable for show. The largest tuber is* 7 7-12 *inches in length and weighs* 2.301 *pounds.*

34 varieties and separated them into four classes as to their quality after cooking.* It will be noticed that those estimated as best in this respect are very low in starch and highest in protein, while the 12 varieties estimated poorest from the culinary point of view are comparatively rich in starch and poor in protein. In the same investigations the authors made a cooking test of even a larger number of varieties and their tabulation shows that those varieties considered best for table use are more resistant to boiling, or retain their form and remain solid or soggy after cooking; while those varieties considered poorest from a culinary standpoint broke down and became mealy after a short period of boiling.† From these

* Annales de la Science Agronomique, 2 ser. 1897, p. 276.

† Annales de la Science Agronomique, 2 ser. 1897, p. 278 et seq.

analyses and tests, the authors draw the conclusion that the culinary value of the potato is directly proportional to its total nitrogen content and inversely proportional to its richness in starch.‡

TRADE ESTIMATES OF QUALITY.

There are trade estimates of quality in potatoes which have no direct relation to the culinary or structural considerations. These may be classed as size, surface aspects and shapeliness, and variety considerations.

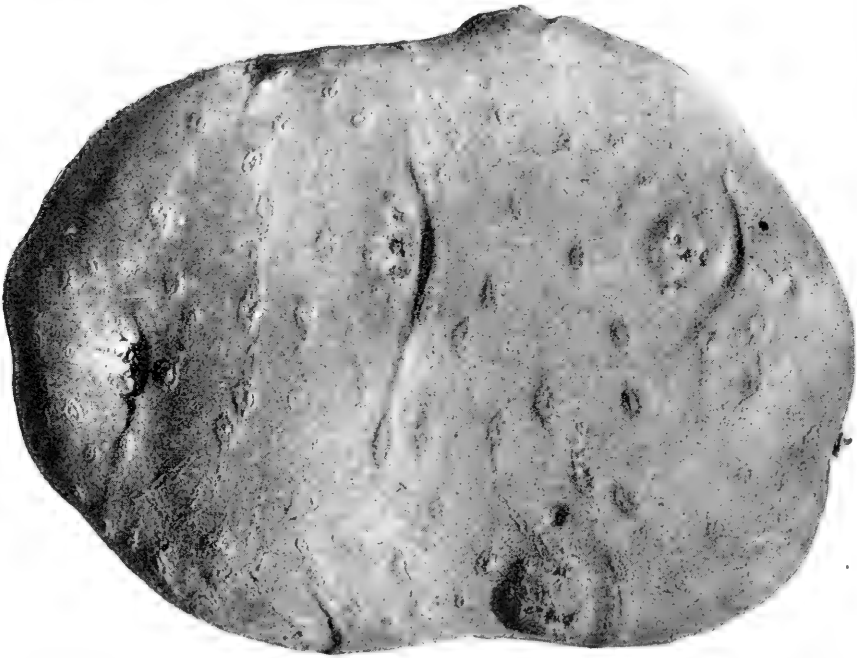

FIG. 173.—*Tuber showing lenticels on the surface. All of such tubers examined have been of good quality.*

Usually the trade does not call for potatoes of excessive size. (Fig. 172.) Those ranging from two to three inches in length and weighing from 5 to 10 ounces are most acceptable. If smaller than this, for whole boiled or baked potatoes, they are non-uniform in cooking qualities and do not look well when put upon the table. If very large, full weight is not given when the tubers are measured

‡ "Le valeur de la pomme de terre est directement proportionnelle à sa teneur en matières azotèes totales et inversement proportionnelle à sa richesse en fecule." Annales de la Science Agronomique, 2 ser. 1897, p. 290.

in the crate. Then, too, in preparation for cooking, the large tubers have to be cut in order that they may be uniformly cooked before the small ones are overdone. There is slightly more waste also in paring. The surface aspects and general shapeliness of the tubers are perhaps the greatest considerations of the discriminating consumers. In northern latitudes potatoes with light yellow or whitish skin are in preference so far as color is concerned, while in many of the southern states the pink-skinned tubers are liked better. So far as we are able to determine, the pink-skinned varieties are in general quite as good in quality from a culinary point of view as those of light or yellowish color. The blue and dark tubers are not desirable for table use except for salads and garnishings. Excepting the potatoes put on the market as earlies, those having a more or less netted skin, or those whose skin has a corky appearance or touch, are usually preferred to the smooth and clear-skinned tubers. This appearance or touch is, in some instances, a variety characteristic, but in general it indicates a degree of maturity or development which promises good cooking quality. On the other hand, the potatoes of smooth and clear skin are oftentimes excessively watery or immature. The presence of lenticels is not objectionable, for they usually indicate normal growth and development in a healthy environment. (Fig. 173.) Potatoes with numerous and deep eyes are also objectionable because they may carry much dirt, and the labor, time and waste in preparing them for cooking are much greater than is the case with potatoes of even surface.

The same objections of time, labor and waste bear upon potatoes of non-uniform or irregular shape. Tubers having deep notches and quick curves in their surface are usually avoided, while those of oval, flat-round and elongated-oval shape are most desirable.

Quality in potatoes, from both the culinary and trade points of view, varies to a limited extent in different varieties; but as a general rule, a knowledge of variety characteristics is possessed only by those who have given the question some study. However, it is a matter of common observation that some varieties resist rot in storage better than others and some deteriorate in cooking quality after going into storage. Undesirable flavors or colors are developed and sometimes the tendency to break down into a mealy condition upon boiling diminishes. In spite of all these distinguishing features, it is very difficult to separate individual tubers or varieties of poor quality from those of good quality upon a superficial examination. It is very seldom that a person can go into the storage room and select the varieties of desirable quality from the undesirable with any great degree of certainty.

The primary object for which potatoes are produced in the United States is for table consumption. In Germany and in parts of France, on the other hand, they are grown in large quantities for other purposes, such as for starch making, from which alcohol may be produced, and for feeding purposes. Hence, from our present point of view the estimate of quality in potatoes might well be based upon their culinary properties; and it is suggested that mealiness in cooking, color and flavor be considered as the principal factors in this estimate.

THE REAL BASIS OF QUALITY IN POTATOES.

The scope of this bulletin is a study of some of the factors in the growth and development of potatoes which influence their culinary quality, special attention being given to their texture when boiled in water. The subject has been very little studied from this point of view. Coudon and Bussard, two French scientists, whose work has already been mentioned, gave the matter some study and published their conclusions in Annales de la Science Agronomique, 2d series, Vol. I, 1897. Their conception of what constitutes a good potato differs materially from our estimate of quality. They consider that the cooking varieties of potatoes from the point of view of their chemical composition, are characterized by:

(1) Aqueousness; (2) Richness in nitrogenous matter, principally in albuminoids; (3) Relative poorness in starch.

They further consider that "The resistance to boiling in water . . . without breaking down in structure does not (hold) depend, as one might believe, on a high content of pectic bodies, more than on a paucity of starch. This resistance seems due, more or less, in a large measure to the proportion of albuminoids which they contain compared with their starch content. Among the varieties studied in 1895 all those in which the proportion of albuminoids to 100 parts of starch fell above 8.6 resisted the boiling in water completely, while those falling below that average varied appreciably. Breaking down was complete in those varieties in which the proportion was below 6.6."

From our own studies and investigations extending over two years, it seems that the culinary and dietetic quality of potatoes is not dependent upon chemical composition so much as it is upon the anatomical (and perhaps physiological) characteristics of the tuber, and the arrangement and distribution of starch and water areas in its substance. The structural characteristic of the tubers is influenced by the conditions of the soil, and of the soil and atmospheric climate in which the potatoes grow.

As a result of these investigations we are led to believe that the quality of mealiness of a potato when boiled, and, to a considerable extent, the flavor, is influenced in the main by the following considerations:

1. *The daily range of soil and atmospheric temperature during the growing period.*

2. *The degree of ripeness of the tuber when the plant dies.*

3. *The physical condition and type of the soil.*

The first two of these considerations have been studied carefully during the past two years, and studies along the same lines are planned for several years to come. The third consideration has not yet been studied experimentally, but is considered a factor at this time, in influencing the quality of potatoes, from general experience and observations.

Parts of a Potato.

In these investigations, while cooking and tasting were the final tests of quality, yet in order to train the judgment and to ascertain the physical features or characteristics which might be considered as factors regulating this estimate of quality, the tubers were examined both externally and internally. If a cross section of a tuber is made and a slice about 2 mm. in thickness from this section is held up to the light, or even carefully examined by reflected light, four zones or areas will be recognized. (Fig. 174.) Using the nomenclature followed by Coudon and Bussard, these are:

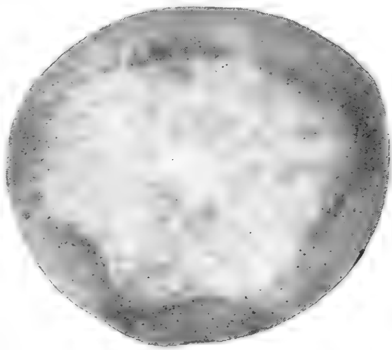

Fig. 174.—*Cross-section of tuber showing the zones. The envelope or skin may not be recognized.*

1. The Envelope or Skin comprising the corky covering of the tuber.

2. The Cortical Layer which is just within the envelope and varies from one-eighth to one-half inch in thickness. This part is generally more dense than any other and is separated from the interior by a well marked ring of fibro-vascular bundles. Within its substance it also contains more fibro-vascular bundles than the other parts.

3. Within the cortical layer is the External Medullary area which comprises the main starchy part of the tuber. This part varies considerably in uniformity.

4. The Internal Medullary area occupies the central part of the tuber and often having branches permeating the external medullary area. This area is usually more or less translucent, inasmuch as it contains mostly water and but little starch.

According to Coudon and Bussard, these parts are divided in the potato body in the following percentages:

Envelope (av. two varieties)	8.79 per cent.
Cortical layer (av. two varieties)	36.19 per cent.
External medullary area (av. five varieties)	34.17 per cent.
Internal medullary area (av. five varieties)	14.96 per cent.

In our examination the following features were noted:

1. *Surface and texture of skin—Surface uneven with deep eyes;* undesirable for market considerations. Texture of skin: *Netted,* indicating a degree of maturity, and, as a general rule, good quality. *Smooth,* indicating a degree of immaturity, hence poor quality and tendency to undesirable flavor. *Scabby,* often mealy and of good color, but undesirable for market considerations. *Exposed,* heavy and soggy in cooking and of poor color with undesirable flavor. *Compound,* indicating non-uniform growth and development; non-uniform in cooking quality and often of poor flavor.

2. *Cortical layer—Thick and dense* (Fig. 174); tubers of poor quality, indicating that they grew near the surface where the temperature and moisture conditions were more variable. *Thin and more translucent,* indicating soil and climatic conditions more favorable to development. Density in this portion is due, to some extent, to the presence of fibro-vascular bundles and cellular contents other than starch; but we believe it is brought about in a greater measure by the thickness and opacity of the cell walls. The contents of the cells of this portion as compared with that of the cells of other portions has not been worked out, but according to Coudon and Bussard* not only are fibro-vascular bundles more abundant, but this portion is richer in nitrogenous matters.

Just how far thickness and coarseness in this portion may be due to the influence of moisture and temperature in the soil cannot be stated at the present time.

3. *External medullary area—Uniform,* indicating an even distribution of starch in the cells and also of the starch-containing cells throughout the part. *Non-uniform,* indicating an uneven distribution of starch cells interspersed with water areas. It was generally observed that uniformity in this part of the tuber was found in tubers which seemed to have grown in favorable conditions of tem-

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* Annales, etc., pp. 257 and 269.

perature and moisture. Non-uniformity, with an abundance of small water areas, or branches of the internal medullary area, was usually observed in those tubers which grew very near the surface, or in those which gave evidence of immaturity. As this portion constitutes the bulk of the tuber (34.176 per cent. of it according to Coudon and Bussard, Reference cited p. 220), a careful estimate of its appearance and texture is important.

FIG. 175.—*Showing the relative size of cooked starch grains at the right and uncooked at the left.*

4. *Internal medullary area—Large and branching,* indicating a large proportion of potato substance which does not contain enough starch grains to break down the cell walls when the tuber is boiled in water. Instead of being full of starch grains, as is the case with the cells of the external medullary area, the cells of this portion are filled for the most part with water, hence the portion has a more translucent appearance when held to the light (Fig. 177). When this portion is branching the starch area is permeated by these water areas and is not uniform. *Small,* indicating a diminished proportion of watery substance and more uniformity in the starch area.

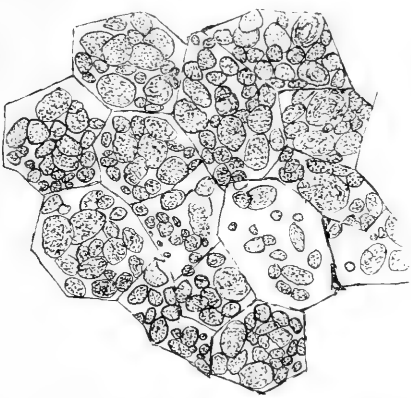

FIG. 176.—*From the external medullary area showing the abundance of starch in the cells of this part.*

5. *Texture of tuber when cut with a knife—Crisp,* when the cut is brittle and snappy, indicating maturity of starch grains and a uniform cellular structure with thin walls. *Leathery,* when the cut is soft, smooth and even, indicating an overgrowth in thickness of cell wall, and oftentimes an inadequate supply of starch.

A careful study of the foregoing characteristics seems very pertinent because it is a matter of common knowledge that the average person cannot distinguish between tubers of good quality and those of poor quality when they are mixed in bulk. It is therefore very desirable that some physical feature or aspect be found which will enable one to recognize potatoes of good quality upon superficial examination. The degrees of quality in the table on page 223 is expressed numerically upon an estimate of all of these factors, and also upon the mealiness or sogginess of the tuber when boiled in water.

WHAT CAUSES MEALINESS?

In cooking, mealiness is the most important consideration in estimating quality. In general, mealiness follows upon the presence of sufficient starch in the cell to rupture its walls when boiled in water. The grains of potato starch expand and coalesce when boiled in water (Fig. 175), and if the cells are sufficiently full of these bodies (Fig. 176) the boiling will cause the cellular structure to be broken down and a degree of mealiness is the result. When the requisite amount of starch is not present in the cells (Fig. 177), its walls are not broken down in cooking, hence the tuber retains its form, or is soggy. When the internal medullary area is large and branching (in the variety Doe's Pride) the external medullary area is not uniform, and when the tuber is boiled in water it is hard and soggy or it contains portions which will not mash uniformly and readily. That there is a marked difference between the starch content of these two portions is shown by chemical analyses, by microscopical examination and by the specific gravity. Coudon and Bussard (Ref. cited p. 220) found upon chemical analysis of five varieties, the following percentage of starch, protein and water in the different portions:

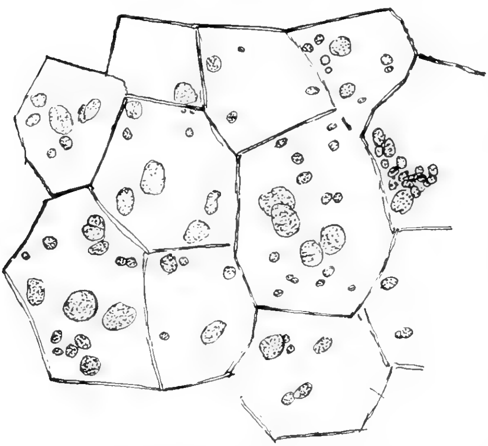

FIG. 177.—*From the internal medullary area showing the paucity of starch in the cells of this part.*

	Starch per cent.	Protein per cent.	Water per cent.
Cortical layer and skin	15.784	2.173	76.57
External medullary area	17.324	2.291	78.43
Internal medullary area	12.75	2.457	81.13

In three samples we found the specific gravity of each of these portions to be as follows, each pair of samples as numbered being taken from the same tuber:

External medullary area		Internal medullary area	
(1)	1.1156	(1)	1.0716
(2)	1.0960	(2)	1.0219
(3)	1.0578	(3)	1.0513
Average	1.0898	Average	1.04826

If, as stated, the starch grains expand when boiled in water, it would seem that a cooked tuber ought to be greater in volume than a raw one, but this is not the case to any marked extent. The boiled tuber contains about the same percentage of water as a raw one. In order to determine this point, two trials were made with results as follows:

DOE'S PRIDE.

I.	Original weight of tuber	184.78 grams
	Weight of tuber peeled	148.1 grams
	Loss of weight in peeling	36.68 grams
	Weight of tuber cooked	144.64 grams
	Loss of weight by cooking	3.46 grams
	Per cent. loss	1.87 grams

This tuber was of decidedly poor quality (immature), remaining soggy and retaining its form after cooking. Not all of the loss was due to the difference in water content, however, as some solids were extracted in boiling.

II.	RURAL NEW YORKER.		EARLY MICHIGAN.		WONDERFUL.	
	Baked.	Boiled.	Baked.	Boiled.	Baked.	Boiled.
	Grams.	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*
Original weight of tubers	549.5	665.52	451.52	308.21	289.	218.1
Weight of tubers, peeled	....	569.7	......	252.3	......	173.5
Loss in peeling	....	95.8	......	55.91	......	39.6
Weight of tubers, cooked	479.2	572.91	372.6	243.45	229.	162.5
Loss or gain in cooking	—70.30	†3.2	—78.81	—8.85	—60.	—10.91
Per cent gain or loss	—12.79	+.48	—17.46	—2.87	—20.76	—6.29

These tubers were rendered mealy by cooking and were of good flavor and color. As was to be expected, those baked lost some moisture, but the loss was not great. Those boiled lost moisture in each case except one, when the gain was slight. It should be stated, however, that in another boiled sample of Wonderful, not recorded here, there was a gain of 9.63 per cent.

These figures and observations seem to point to the conclusion that although the starch grains expand greatly on boiling, yet the volume of potato substance is not materially increased because in expanding, the starch grains incorporate the water which was originally in the tuber in a free state. In other words, the mass acts some-

FIG. 178.—*Tuber growing in a sloping position. The stick above the level of the soil.*

what as a sponge. If the cortical layer is thin, the skin netted, and the external medullary area uniform, the texture crisp and the internal medullary area small, the tuber generally becomes mealy when boiled.

ACCOUNT OF EXPERIMENTS.

The characteristics of quality which have been mentioned may vary slightly in different varieties of potatoes. For these studies Doe's Pride was used. This is a late variety, and in general, one producing a good yield. It is oblong-oval in shape, with long, medium to shallow eyes. The skin has a slightly pinkish tinge when fresh dug, and tends to become netted when mature. The tops grow large and vigorously and are fairly resistant to disease. During the growing season of 1903, no data upon soil or air temperature were recorded, but it was ascertained upon careful examination and study, that tubers of this variety growing at different depths varied in cooking quality and it was further observed that structural characteristics varied with the depth at which the tubers grow. It was supposed that the temperature and possibly the moisture content of the soil, had throughout the growing season an influence upon these characteristics of the tubers. In order further to investi-

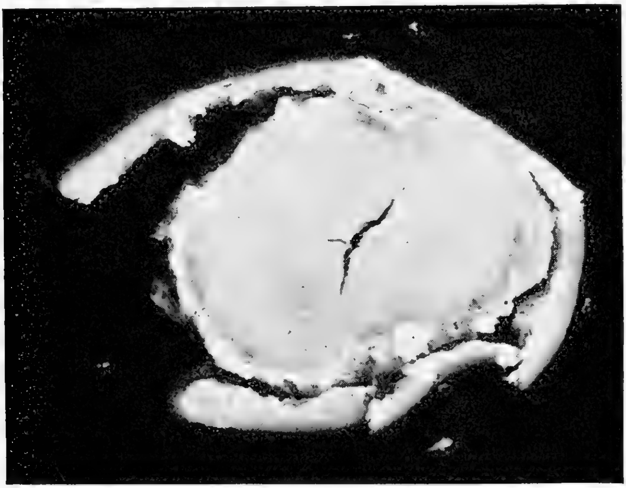

Fig. 179.—*Cross-section from the stem end of a tuber three inches long, growing in a sloping position with bud end one inch below the surface. The section was one centimeter thick and boiled for twenty minutes. Compare Figs.* 180 *and* 181 *from the same tuber.*

gate these influences during the season of 1904 the same variety of potatoes was planted May 12, on three adjacent plats, at depths of two, four and six inches. The temperature was taken by the electric method devised by the Bureau of Soils, Washington, D. C., and described by Elwood Mead and Lyman J. Briggs in Bulletin 15 of the Bureau of Soils. Resistance coils were planted in duplicate, in the middle row of each plat at such points as would promise uniform temperature readings. These were planted in a horizontal position at the same depth as the potatoes in their respective plats. During the growing season, from May 14 to Sept. 24, the temperatures were read every two hours for a period of twenty-four hours on Saturday and Saturday night of each week. The air temperature readings covering the same hours each week were taken by the U. S. Weather Bureau with apparatus located about two hundred yards distant from the potato plats. At five o'clock in the afternoon of the days (Saturdays) upon which temperature readings were taken, samples of soil were taken from the whole plat in duplicate at the depth of two, four, six and eight inches for the purpose of determining the moisture content. Inasmuch as the surface of the three plats, as a whole, is rolling, the soil samples were taken one on the lower side and one on the upper side each time.

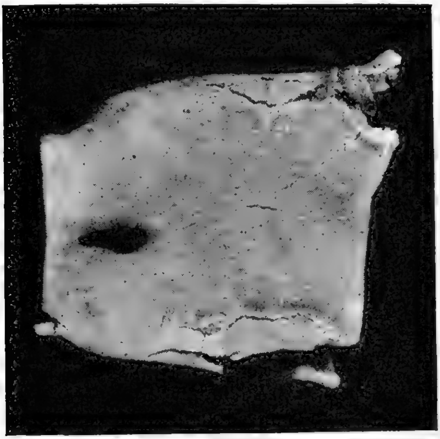

FIG. 180.—*Longitudinal section from the middle portion of the same tuber from which Fig.* 179 *was taken. The section is of the same thickness and boiled in the same manner. The stem end may be recognized by the cleavage of the substance. There was a small cavity in the bud end. Compare Figs.* 179 *and* 181.

Level culture was given, and during the growing season the plats were cultivated six times and sprayed with Bordeaux and Paris green five times.

When the potatoes were dug, note was made of the depth at which each tuber grew, and later each tuber was weighed and examined both internally and externally and scored upon a series of points upon which the quality was estimated. (See table p. 228.)

The soil in which the potatoes were planted is of the type known as Dunkirk gravelly loam. It is a good potato soil, although in this particular area the underlying subsoil, which is not so productive as the surface soil, lies too near the surface to give the roots the feeding area below that they would seem to demand. It was soil adjacent to this plat, and of the same type, which produced yields of potatoes of from 300 to 350 bushels per acre for a series of successive years without the addition of fertilizers or manures. (See Cornell Bulletins.)

During the growing season, hills of potatoes from each plat were dug in order to study the position of the tubers in relation to the seed set and also to observe the development of the root system. In no instance was a tuber found growing beneath the seed tuber; unless, as in one or two cases, they were forced below by the presence of a stone. Doe's Pride has a tendency to grow somewhat long, sometimes the tubers being two and one-half times their diameter. In instances where the tubers were found growing from two to four inches beneath the surface, they seemed to have a general tendency to grow in a sloping position with the bud end slanting upward (Fig. 178). In many instances in which the tubers were sufficiently long, and the bud end came very near the surface there was a difference between the two ends in the physical structure and relationship of parts, and consequently a difference in the cooking quality (Figs. 179, 180, 181). This fact seems to add evidence to the belief that temperature and moisture conditions in the soil have a marked influence on the quality of the tubers. Whether, however, the difference in quality between the two ends is due wholly to soil-climatic influences cannot be definitely stated, for, as will be shown later, the quality varies with ripeness, and it may be that the bud end of these long and sloping tubers is of later development than the stem end and that the quality difference is one depending upon the degree of maturity and starch development. Whether there is a difference between the starch content of the two ends, is a pertinent question and one yet to be considered further. Analyses of the ends of three tubers of the present year's crop show starch and protein content as follows:*

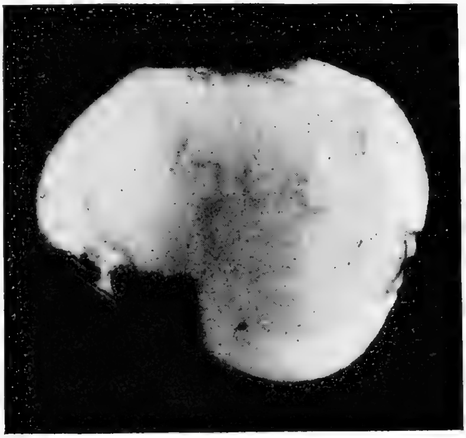

FIG. 181.—*Cross-section from the bud end of the same tuber from which Figs.* 179 *and* 180 *were taken. The same treatment was given as to sectioning and boiling. This portion retained its form even after boiling thirty minutes. Compare Figs.* 179 *and* 180.

* Analyses made by Dr. J. A. Bizzell.

		Dry matter.	Starch.	Protein.
		Per cent.	*Per cent.*	*Per cent.*
Tuber I...	bud end	22.17	16.27	2.69
	stem end	23.89	18.16	2.67
Tuber II..	bud end	20.65	14.68	2.65
	stem end	25.50	19.2	3.09
Tuber III.	bud end	22.67	16.38	2.64
	stem end	25.66	19.33	2.73
Average...	bud end	21.83	15.77	2.69
	stem end	25.016	18.94	2.83

The analyses of only three tubers from one season's growth are not sufficient to base conclusions upon, but it is believed that further analyses will not materially alter the figures.

This periodic digging revealed the fact also that, as a general rule the tubers of this variety grow in close proximity in the hill. This habit perhaps causes more tubers to become exposed when planted shallow through crowding upward than would be the case if they were more scattering in the hill.

The following table shows the position which the tubers occupied in the soil by number, weight and percentages according to the depth planted:

		Numbers and Weights.			Percentages.		
Depth planted		2 in.	4 in.	6 in.	2 in.	4 in.	6 in.
Number of hills		85	85	85	85	85	85
Number of tubers		1050	996	912	1050	996	912
Weight, Kgs		74.867	86.812	113.440	74.867	86.812	113.440
Size	Large	294	435	496	28	43.67	54.26
	Small	756	561	417	72	56.33	45.74
Exposed...	Number	514	204	113	48.95	20.48	12.39
	Wt., Kgs	28.712	13.617	15.891	38.35	15.68	14.008
1–3 inch...	Number	536	365	280	51.047	36.64	30.7
	Wt., Kgs	46.155	37.639	42.736	61.64	43.35	37.67
2–4 inch...	Number	......	234	213	......	23.49	23.35
	Wt., Kgs	......	19.019	24.247	......	21.908	21.37
3–5 inch....	Number	......	183	208	......	18.37	22.81
	Wt., Kgs	......	15.827	24.046	......	18.23	21.19
4–6 inch...	Number	......	10	98	......	1.004	10.74
	Wt., Kgs	......	.710	6.520	......	.82	5.74

Some points shown by this table are worthy of note.

The hills growing at a depth of two inches bore more tubers than those planted at four and six inches, but the tubers at two inches were least in total weight. As the depth of planting increased the total number of tubers decreased, but the total weight increased. It was readily noticeable that small tubers were much in excess over the large ones for those hills in the two-inch plat. In reference to small tubers, it should be noted, however, that in the division adopted for these studies those tubers were considered small which did not exceed four ounces in weight. This limit of weight for a small tuber is somewhat high, but it seemed feasible to make the division at this weight in order to be able to render more accurate judgment as to quality. In ordinary commercial grading, the small tubers include those of about two ounces and less.

FIG. 182.—*Where seed tuber is planted two to three inches beneath the surface of the soil the growing tubers soon become exposed or subjected to adverse temperature conditions.*

It will be noticed that the number and weight of exposed tubers for those hills planted two inches deep is high. This is due to the fact that the seed piece was not planted deep enough to permit the tubers to form wholly beneath the soil. As these plants yielded quite abundantly it was observed that toward the close of the season the tubers raised the soil, and as this was later washed off by the rains, many tubers which began their growth beneath the surface were rendered exposed. (Fig. 182.) In this connection, it should be noted that inasmuch as tubers are borne at the nodes of the stem beneath the surface of the soil, in the instance of those hills planted two inches deep, there was not enough room between the seed set and the surface for the number of tubers to be borne which the plant was capable of producing. Hence many of them were crowded out of the soil. Nine per cent of the plants planted at a depth of two inches bore tubers upon the stem above ground, while none were thus borne by those planted at depths of four and six inches.

It will be observed that the majority of tubers were produced at a depth of two to five inches, and these were also of most desirable shape and size. The tubers growing in depth from two to five inches are superior in quality to those shallower or deeper. Those found nearer the surface than two inches were usually of inferior color and were elastic and tough in their texture, remaining soggy and heavy after boiling. Those deeper than four inches were oftentimes watery and seemed to be immature both in regard to starch development and cellular structure. By average, they were also smaller.

It should be noted further that the plat upon which tubers were planted at six inches in depth yielded best, both as regards number, size, shape and weight of large tubers. It is true, too, that the tubers of this plat were superior in quality, as is shown by the table below.

Our investigations have not yet gone far enough to enable us to say what is the optimum temperature, either in the soil or in the air, for the best growth and development of the potato. The experiments seem to bear evidence, however, that the temperature of the soil in which the potatoes grow has some influence upon the quality. The ratings of quality, the number, weight and percentage of potatoes planted at different depths, are shown in the following table:

TABLE SHOWING DEGREES OF QUALITY ACCORDING TO DEPTH PLANTED.

				Percentages.		
Depth planted	2 in.	4 in.	6 in.	2 in.	4 in.	6 in.
Number of hills	85	885	85	85	85	85
Number of tubers	1050	996	912	1050	996	912
Weight, Kgs	74.867	86.812	113.44	74.867	86.812	113.44
Quality 0–50, Number	854	561	342	81.33	56.32	37.5
Quality 0–50, Wt., kgs	40.847	22.967	24.012	54.56	26.45	21.16
Quality 50–65, Number	81	43	77	7.714	4.32	8.44
Quality 50–65, Wt., kgs	12.771	3.558	12.588	17.05	4.09	11.09
Quality 65–80, Number	98	217	255	9.33	21.78	28
Quality 65–80, Wt., kgs	17.425	37.171	31.870	23.27	42.82	28.09
Quality 80–95, Number	17	175	238	1.619	17.57	26.09
Quality 80–95, Wt., kgs	3.826	23.116	44.97	5.11	26.62	39.64
Scabby, Number	119	29	38	11.33	2.91	4.16
Scabby, Wt., kgs	8.691	3.302	2.835	11.608	3.803	2.5
Compound, Number	47	17	14	4.476	1.707	1.535
Compound, Wt., kgs	5.610	3.791	3.118	7.49	4.37	2.748

These figures are reduced to percentages in the three columns on the right. No tubers were rated above 95 in quality because no ideal or standard of quality has been established, and it was not known how the best quality of Doe's Pride would compare with the best quality of some other variety.

The 0-50-quality class includes all the small tubers which were immature, and those scabby or exposed and, consequently, of no value for culinary purposes. More than four-fifths of the number and more than half of the weight of the tubers on the two-inch plat are in this class. This plat also leads the others in both the number and weight of tubers in the 50-65-quality class, but from the quality grade of 65 and upward the order for the plats, in both number and weight of tubers, is reversed.

The greatest number and weight of tubers of the best quality were produced on the six-inch plat where the temperature and moisture conditions were most constant.

The six-inch plat, however, produced more scabby tubers than the four-inch plat, but these were, as a rule, small and seemed to be immature. They also grew at the lowest depths. It may be that the constancy of both the temperature and moisture at the depth of five or six inches promotes the development of the scab. It is also a question whether the scab on the tubers of the two-inch plat was produced by the same fungus or agency as that upon the tubers of the six-inch plat.

TABLE SHOWING THE MEAN TEMPERATURE IN THE SOIL AT THREE DIFFERENT DEPTHS, ALSO THE TEMPERATURE OF THE AIR.

DATE.	Depth of 2 inches.	Depth of 4 inches.	Depth of 6 inches.	Temperature of the air.
May 14	66.1	63.1	61.9	57.57
21	60.	60.2	60.	60.23
28	61.20	61.	60.7	58.38
June 4	69.91	68.7	67.5	70.15
11	63.3	61.7	61.7	58.77
18	68.8	68.3	67.6	66.27
25	75.8	75.3	74.2	80.07
July 2	61.7	62.7	63.3	56.3
9	68.	67.7	67.4	69.11
16	69.4	70.3	69.	69.92
23	66.4	67.	66.6	63.07
30	66.5	66.6	65.7	70.15
Aug. 6	68.	68.	67.4	69.7
13	65.7	65.7	65.6	67.
20	65.	64.8	65.	67.15
27	63.	63.2	63.4	61.65
Sept. 3	71.	70.5	70.5	70.69
10	64.3	63.7	63.8	63.03
17	61.7	61.5	61.3	66.03
24	56.4	55.6	56.5	63.5
Average	65.58	65.27	64.97	65.437

A point which we would call particular attention to, as indicated by the table and the chart, is the small difference between the mean temperature of the different plats during the twenty-four hours over which the observation extends. Upon studying the temperature curves of the different plats for the same period it was observed that the temperature of the two-inch plat runs considerably higher and lower than that of the others. This wide variation of the hourly temperatures and comparatively uniform temperatures for the twenty-four hours, embracing a night and a day, between the

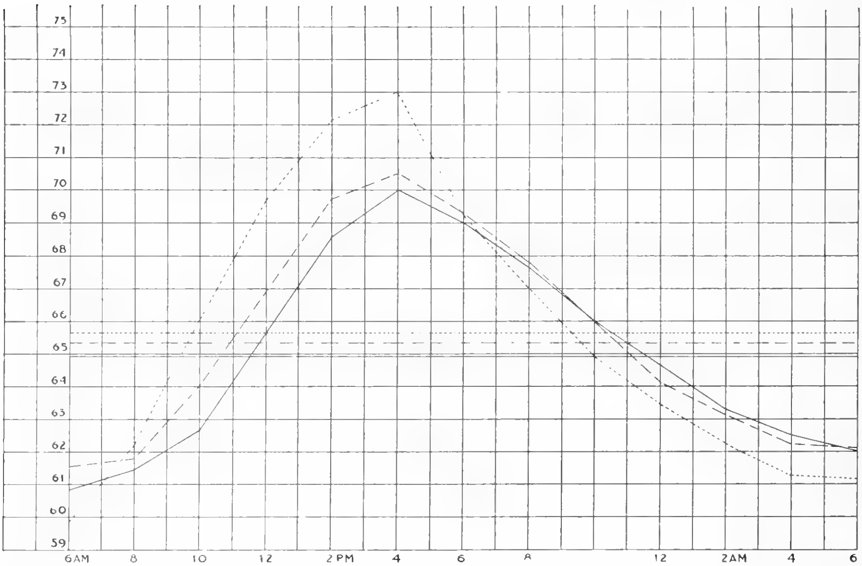

FIG. 183.—*Chart condensed from 20 weekly records during the growing season, showing the range of temperature in the soil at different depths by periods of two hours beginning at 6 A. M., with averages.*
Solid line represents temperature at 6 inches.
Dashed line represents temperature at 4 inches.
Dotted line represents temperature at 2 inches.

different plats points to the conclusion that the quality of the tuber is not so much affected by the sum total of temperature units, within reasonable limits, as it is by the hourly variation of temperature through the twenty-four-hour cycles during the growing season.

It will also be noted that the mean temperature of the air for the twenty-four-hour periods is not greatly different from the mean temperatures in the soil for the same period, though the hourly variation is markedly different.

The moisture content of the soil during the growing season has a marked influence upon the quality of potatoes as well as upon the yield, but it is also impossible at the present time to say what the optimum moisture conditions are. And it is likewise impossible to say which of the two factors, temperature and moisture, is the more important or more potent in determining the quality of potatoes. During most of the growing season, samples of the soil were taken at 5 P. M. in duplicate at depths of two, four, six and eight inches. These samples were taken from the corresponding positions on the east and west sides of the area planted, by carefully digging out the soil with a trowel to the required depth and sifting it through a .5mm. sieve, after which it was immediately sealed in glass jars and taken to the laboratory for the moisture determination. The following table shows the percentages of moisture taken each week practically throughout the growing season, at the different depths and with averages:

Table Showing Percentage of Moisture at Different Depths, with Averages.

DATE.	Depth of 2 inches.	Depth of 4 inches.	Depth of 6 inches.	Depth of 8 inches.	Average.
May 14	15.26	15.495	17.34	15.825	16.0025
21	15.40	15.45	16.285	16.66	15.84
28	16.984	16.792	17.88	17.143	17.199
June 4	14.32	17.64	19.33	18.27	17.39
11	13.86	15.30	15.95	16.07	15.59
18	12.915	15.30	16.365	16.43	15.535
25	10.195	15.55	16.39	15.51	14.411
July 2	11.905	14.44	14.93	16.18	14.3637
9	9.80	14.22	15.435	15.06	13.603
16	13.599	15.60	16.12	15.565	15.237
23	16.795	16.95	16.565	15.85	16.537
30	14.23	16.00	16.52	15.87	15.6575
Aug. 6	13.915	14.58	15.79	16.27	14.939
13	14.335	15.02	15.77	16.15	15.319
20	16.255	16.37	16.255	16.07	16.425
27	8.755	13.315	14.215	14.55	12.709
Sept. 3	10.885	12.28	12.35	12.585	12.025
10	9.405	11.535	12.52	13.155	11.653
Averages	13.267	15.118	15.91	15.688	14.995

As might be expected, the moisture content of the surface two inches runs much lower than the deeper layers, during the growing season, and it is much more variable in this uppermost layer. It is believed that this variation in moisture has a deleterious effect upon the quality of the potato, especially in the tendency to develop coarse cellular structure, and, to some extent, in influencing the tendency to compound growth.

It will be seen from the table that the highest averages in moisture content are for the six-inch depth. It was between four and six inches that the most tubers of the best quality grew.

RIPENESS, A FACTOR OF QUALITY.

On page 219, "the degree of ripeness of the tuber when the plant dies" was stated as a second prime factor governing quality of potatoes. That this is an important factor is emphasized by the fact that in the wholesale potato markets of Buffalo and New York, potatoes which are known to have been grown in the neighborhood of canning factories are either avoided, or accepted at a lower price, because of the probability of their being poor in quality. The relationship of potatoes of poor quality and the canning factories was found to reside in the practice of the farmers in the neighborhood of factories of planting a crop of early peas, tomatoes or beans which could be harvested by the first to the fifteenth of July, and afterwards planting the same land to potatoes. Planting thus late, the tubers do not have a normal season for growth and development, and the plant is compelled to die because of the close of the season before the tubers have reached their normal maturity.

I have called attention to the fact that it is the degree of ripeness of the tubers at the time of the plant's dying at the close of the season that gives this factor its importance, in order to distinguish this condition of unripeness from that of tubers gathered from green and growing plants and which are esteemed of good quality. The factors which render potatoes taken from plants which die normally at the close of the season undesirable, while those of good size taken from green and growing plants are highly prized, are not clearly understood, but it is supposed that the cessation or retarding of growth of the tubers, as the plant dies slowly, causes abnormal development in both composition and cellular structure, while tubers taken from the growing plants are suddenly interrupted in the midst of normal growth and development. Immature potatoes are relatively richer in protein and poorer in starch than normally developed and ripened tubers. The following analyses, calculated on percentage of dry matter, indicate these relationships. These late planted tubers are also more watery:

1903.

VARIETY.	Date planted.	Date dug.	Dry matter.	Ash.	Protein.	Starch.
Green Mt............	May 7	Oct. 20	22.9	4.5	9.77	77.38
Green Mt............	July 6	Oct. 20	18.1	5.56	11.86	72.43
Doe's Pride..........	May 7	Oct. 20	21.75	5.39	10.35	74.28
Doe's Pride..........	July 6	Oct. 20	19.06	5.10	12.11	71.14

1904.

VARIETY.	Date planted.	Date dug.	Dry matter.	Ash.	Protein.	Starch.
Doe's Pride..........	May 21	Sept. 28	21.64	....	13.11	72.38
Doe's Pride..........	July 12	Sept. 28	18.55	....	16.80	65.79

As a general rule, seemingly immature potatoes found in the market are the result of late planting; but it is true that a bulk of normally planted potatoes will contain some immature tubers, being those which did not form until late in the season. L. R. Jones and W. A. Orton of Vermont* show that a considerable part of the yield of marketable tubers developed after September first. It is quite likely, therefore, that a stock might contain many immature tubers. Considerable work has been done at some of the other Stations† in attempts to determine the best dates for the planting of potatoes. But all of these investigations have been conducted in consideration of yield only, and none in consideration of quality. Nearly all of the evidence points to early planting as most satisfactory from the standpoint of yield. When late planting is advocated, it is usually because of certain conditions which enable the plants to escape disease.

Our own investigations along this line cover a period of two years, but in addition to yield, quality also was considered. The following figures indicate the yield of potatoes planted late as compared with those planted early for the two years:

	1903.			1904.		
	Date planted.	Date dug.	Total yield per acre.	Date planted.	Date dug.	Total yield.
			Bushels			
Doe's Pride..........	May 7	Oct. 20	321.46	May 12	Sept. 28	439.59
Doe's Pride..........	July 7	Oct. 20	193.06	July 12	Sept. 28	105.38
Green Mt............	May 7	Oct. 20	411.66	....	....	....
Green Mt............	July 6	Oct. 20	187.87	....	....	....

*Vermont Rep. for 1899.

†Consult the following: Nevada Bul. 20, Mich. Bul. 108, North Carolina Bul. 146, Canada Experimental Farms Rpt. for 1901, and Woburn Experimental Farms Rpt. for 1901.

Late planting is practiced rather extensively in New York State and it is quite probable that the state's yield is kept at the low average of 90 bushels per acre by this practice.

The late-planted tubers of the crops of both years were of poor quality from the consideration of both mealiness in boiling and physical aspects. The seed tubers germinated readily and the plants grew vigorously until the ground was entirely covered. Because of the short season, the late-planted areas could not be cultivated nor sprayed so often as the early-planted portions; yet a greater average number of tubers were formed in each hill, though they were smaller. Toward the close of the seasons as the nights became cool, the plants ceased to grow and finally withered even before frost. The tubers, however, were not mature. In very few instances could one be found with a netted skin, and they did not assume this appearance later in the season, as often happens with mature tubers. In all instances noted, the cortical layer was poorly defined. The external medullary area was not uniform, being permeated by water areas and branches of the internal medullary area. This portion was large in the center with branches more or less well defined running into the surrounding portion. The texture of the tubers as indicated by cutting, was in all instances more or less leathery and watery. As the knife passed through the tuber there was not imparted that feeling of snappiness manifested by tubers of normal development and good quality. To express in exact terms this conception of texture is not an easy matter, but one's judgment soon ripens into a keen sense of the difference. After boiling, these late planted tubers retained their form and were soggy. The flavor and color also were not attractive and the liquor in which they were boiled had a pronounced taste and odor.

The specific gravity of these tubers from the crops of both years was a little less than that of normal tubers, averaging 1.07 and 1.08 respectively. All of these facts and observations point to the belief that in these immature potatoes, starch elaboration and cellular formation had not advanced to normal. Although the vines of the potatoes planted late, as these were, may die normally at the close of the season, yet this does not assure ripeness of the tubers. Maturity is essential to high quality in potatoes.

It was also observed that about 75–80 per cent of these immature tubers were readily attacked by the disease called "Internal brown." This disease seems to be due to some physiological derangement or to bacterial action. It usually takes its origin in the internal medullary area and is indicated at first by a browning of the tissue. Later the tissue contracts and decays and a cavity is formed, rendering the tuber entirely worthless.

QUALITY INFLUENCED BY TEXTURE OF SOIL.

The third prime factor governing the quality of potatoes as expressed on page 219 is "the physical condition and type of the soil." No experiments, however, have been made to demonstrate the influence of these considerations upon either the cooking quality or the physical aspects of potatoes. What evidence we have is based upon general observation and the testimony and experience of others. This evidence seems to point to the conclusion that, all other factors being eliminated, quality is affected by the type and texture of the soil. It may be, however, that these are adjunct factors to the more fundamental factors of temperature and moisture, inasmuch as both the temperature and moisture content would vary with both the type and texture of the soil in its normal condition for growing crops.

One instance may here be recorded which bears evidence that quality varies with the type and texture of the soil. In 1904, we planted two acres of potatoes upon an area which comprised a small portion of Miami fine sandy loam and the remainder of Elmira clay loam of poor drainage. Carman No. 3 potatoes were planted on the entire area. The soil received a dressing of 500 pounds per acre of a 2-6-8 fertilizer, was well tilled and the crop sprayed several times.

At digging time the tubers from the sandy loam area were dug first, and samples, having been tried by several prospective buyers, were pronounced very good. Consequently, orders for their winter's supply were placed, and some of these orders were filled from the supply harvested from the clay area without any foreknowledge or thought that they were of poor quality. In all instances the tubers from the clay loam area were of poor quality, remaining firm and soggy after boiling and almost unpalatable because of their flavor. When baked, however, they were passable.

SUMMARY.

The salient and practical lessons to which this study of soil climate seems to point may be briefly summarized as follows:

(1) Tubers grow out upon a short stem or stalk from the plant stem at regular nodes above the planted tuber. It is therefore necessary to plant five to six inches deep (in good soil) in order that

the plant may have room enough to form nodes to accommodate the tubers which it is able to bear.

(2) If planted deeper than six inches the moisture and temperature conditions are unsuitable for the development of tubers on the first one or two nodes. The tubers are of under size, immature, and somewhat prone to scabbiness.

(3) If planted shallower than three inches, the variation in temperature and moisture is too great for proper development. The tubers are crowded, and there is a large proportion of small, compound, exposed and scabby tubers and also a tendency to produce tubers on the stalk.

(4) Tubers growing between the depths of one and one-half and four inches are of more uniformly good quality in appearance and cooking, in good size, and good development, than those growing deeper or shallower.

(5) Long tubers which grow sloping in the ground will show a difference in cooking quality (mealiness vs. sogginess) between the bud end (end nearest the surface) and the stem end. The stem end cooks more mealy. In most of such instances the stem end is netted, while the bud end has a smooth surface.

(6) Though it cannot be said definitely, it is believed that good quality is developed under a uniform soil temperature of 65–75 degrees. Tubers growing one and two to five inches below the surface are subject to these conditions. Great fluctuation in temperature is detrimental to the best development of potatoes. Tubers growing above the one and one-half inch level are more or less subject to this fluctuation. Uniformly low temperature below 65 degrees, is not conducive to the best development and ripening of the tubers. It may be also that soil texture has an influence on these favorable and adverse conditions.

August, 1905 BULLETIN 231

CORNELL UNIVERSITY

AGRICULTURAL EXPERIMENT STATION OF THE COLLEGE OF AGRICULTURE

Department of Horticulture (Extension Work)

1. SECOND REPORT ON THE FORCING OF STRAWBERRIES.

2. NOTES ON THE FORCING OF TOMATOES, CUCUMBERS AND MELONS.

Marshall.

By C. E. HUNN, JOHN CRAIG

ITHACA, N. Y.
PUBLISHED BY THE UNIVERSITY

ORGANIZATION

Of the Cornell University Agricultural Experiment Station.

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The regular bulletins of the Station are sent free to persons residing in New York State who request them.

COLLEGE OF AGRICULTURE,
CORNELL UNIVERSITY, ITHACA, N. Y., July 15, 1905.

HON. CHARLES A. WIETING,
Commissioner of Agriculture, Albany, N. Y.

Sir:—I submit herewith Bulletin No. 231 by Professor John Craig and Mr. C. E. Hunn on the forcing of strawberries, tomatoes, cucumbers and melons.

This experiment Station has given much attention to subjects connected with greenhouse and closely related work, for this work is very important in New York State. In order to show the extent of the published work I submit an exhibit of the titles of the Bulletins, pertaining to the general subject. Many of these are long since out of print, so that we can now supply to residents of the State only Nos. 134, 136, 147, 186, 190, 200, 227.

7. Influences affecting sprouting seeds.
10. Tomatoes.
15. Sundry investigations of 1889.
21. Tomatoes.
25. Sundry investigations of 1890.
26. Egg plants.
28. Forcing tomatoes.
30. Influence of electric light on green house plants.
31. Forcing English cucumbers.
32. Tomatoes
41. Steam and hot water for heating green houses.
42. Electro horticulture.
43. Trouble of winter tomatoes.
45. Tomatoes.
49. Sundry investigations of 1892.
53. Ædema of the tomato.
55. Green house notes.
61. Sundry investigations of the year.
87. Dwarf Lima beans.
91. Recent chrysanthemums.
94. Damping off.
95. Winter muskmelons.
96. Forcing house miscellanies.
112. The 1895 chrysanthemums.
115. The pole Lima beans.
134. Strawberries under glass.
136. Chrysanthemums.
147. Fourth report upon Chrysanthemums.
186. The sterile fungus Rhizoctonia.
190. Three unusual strawberry pests and a green house pest.
200. Muskmelons.
227. Mushroom growing.

Respectfully submitted,
L. H. BAILEY, Director.

I

SECOND REPORT

ON THE

Forcing of Strawberries.

I. FORCING STRAWBERRIES.

Since the publication of Bulletin 134, entitled "Strawberries Under Glass," issued in April, 1897, the investigation has been continued with a view of studying: The varieties best adapted to forcing; the length of time required to mature a crop from the time of bringing in the plants from the cold frame; the results of temperature on the crop; economy in handling of the plants.

A Discussion of Forcing Varieties.

Taking up the first question, there have been tested nearly one hundred American varieties, eight French varieties and five well

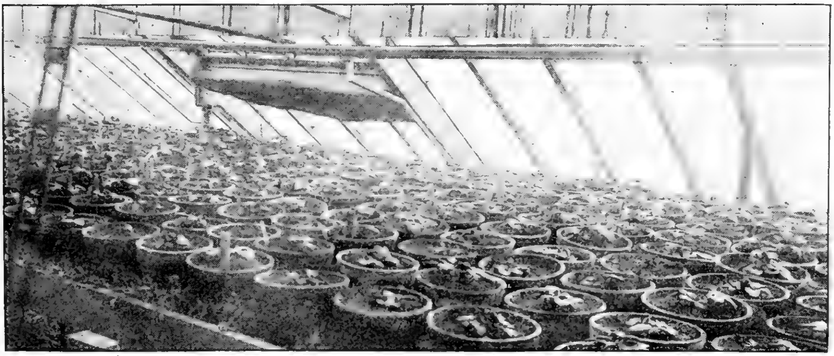

Fig. 1.—*The beginning of growth in the cool house.*

known English forcing varieties. Of this number, but few have been found of value for forcing; and at the present time, the main crop for forcing this winter consists of but three varieties, and these of American origin. Varieties of English origin, popular abroad both for growing in the open and for forcing, appear to deteriorate when brought to this country, rarely holding their excellence more than two seasons, even with careful selection of runners and high cultivation. The French varieties of the Hautboy type, producing fruit of but medium size and of a peculiar musky flavor, are not liked by the average consumer. Again, the long fruiting period of this type of berry is a defect where successive crops are wanted in the same house. The decisive summer peculiar to this country has probably had a tendency to develop varieties that mature crops of fruit quickly, ripening the larger part of the crop within a few days. This habit is one that is essential to a good forcing variety, so that one crop may be gathered within a short period and the plants then all removed at the same time in order that the house may be cleared for the next crop.

Merits of Early versus Late Varieties—At first thought, it would appear that an extra early variety would be preferable to a mid-season or later variety for forcing, but early varieties produce only a small crop of fruits and the berries average small in size. This, coupled with the fact that with greenhouse operations one can to a large extent control the seasons and ripen a crop at will, has discovered the additional fact that the mid-season varieties producing large fruits and yielding an abundant crop, are preferable to either the extra early or late varieties. At the time Bulletin 134 was written, a variety called Beder Wood was considered one of the best for forcing, although the berries were only of average size and of rather light color. Further testing of many kinds led to the discovery of other varieties that forced as well as Beder Wood, had larger, more uniform and higher colored fruit, and ripened practically all the berries on each plant at the same time. Among these are Marshall and Glen Mary, the former a strong-growing, perfect-flowered variety, yielding a large quantity of fertile pollen and producing fruit of extra size and of a very attractive color. Glen Mary has nearly all the characteristics of an ideal forcing berry, the only fault being that the first flowers to open are almost without stamens, and pollen must be supplied by another variety. If this is done, the berries set readily and swell rapidly. The plants make fine crowns and vigorous root growth and thus are able to absorb a large amount of liquid manure when the fruit is swelling.

President is another variety of recent introduction that has proved of exceptional value for forcing. It is a true pistillate, and, contrary to our past experience with such varieties, is equal or superior to any staminate form yet tested. The habit of growth is all that could be desired in a forcing berry. It is stocky, has big crowns that ripen early in the fall, a strong deep root growth, and fruit of extra large size and fine dark red color. Each fruit is well colored over the entire surface, and is without the objectionable green tip. The flowers of this variety remain open for several days, which means that if cloudy weather intervenes, pollenization may be delayed until sunny weather. A minimum amount of pollen is required to set the fruits

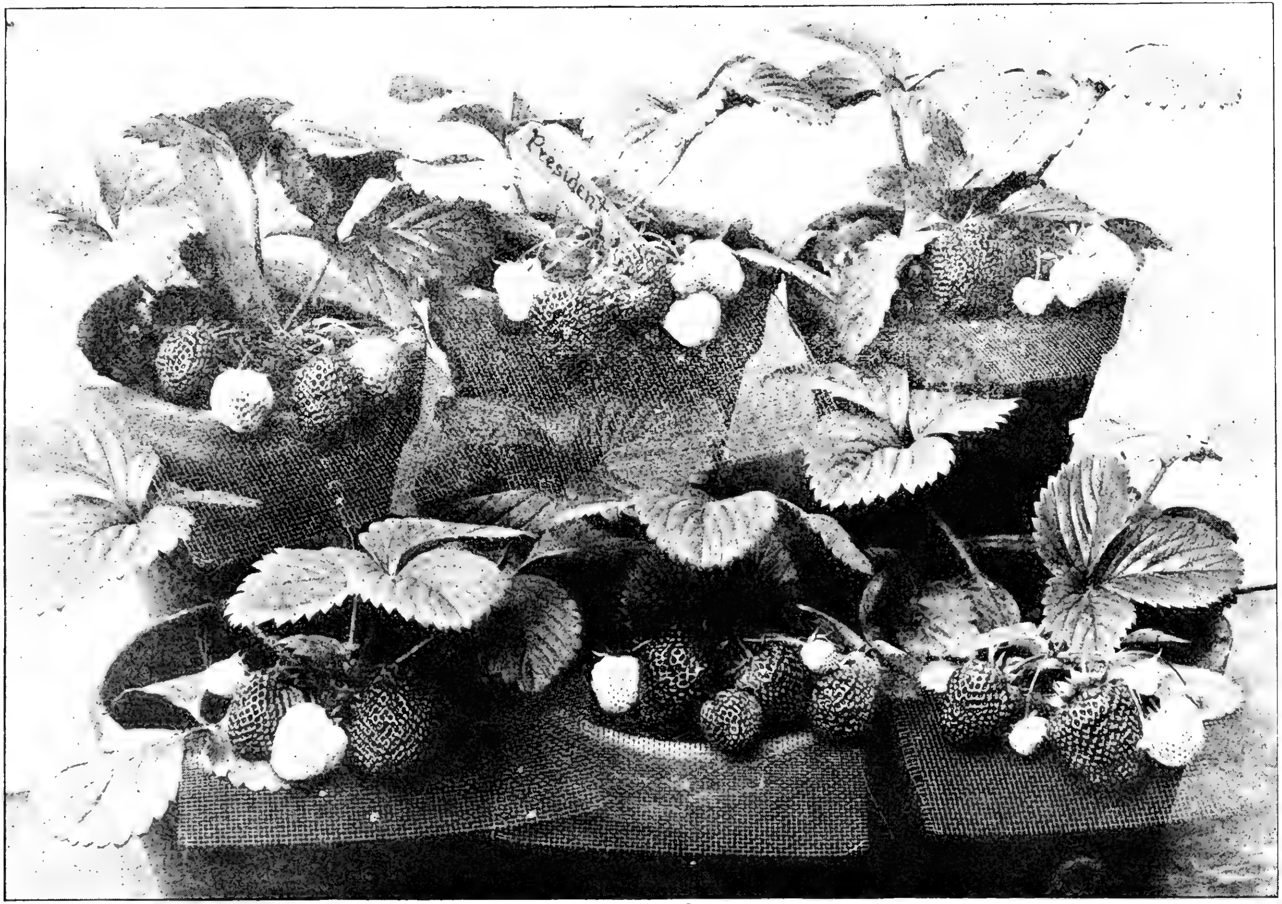

FIG. 2.—*One of the reliable forcing varieties. A fair crop in sight.*

which swell rapidly and ripen evenly after setting. The berry of this variety is firmer than Marshall or Glen Mary and may be shipped to market much easier. The foliage, while of the large type is not heavy enough to shade the fruits, making it a desirable variety to grow either for table decoration or where individual plants are required to be set before each guest at dinner parties. This method of serving strawberries is very popular, and well-grown plants bearing from four to six high-grade berries command high prices. In our local market they have sold for one dollar a plant and will sell in a large city for from two dollars to two and one-half dollars at Easter

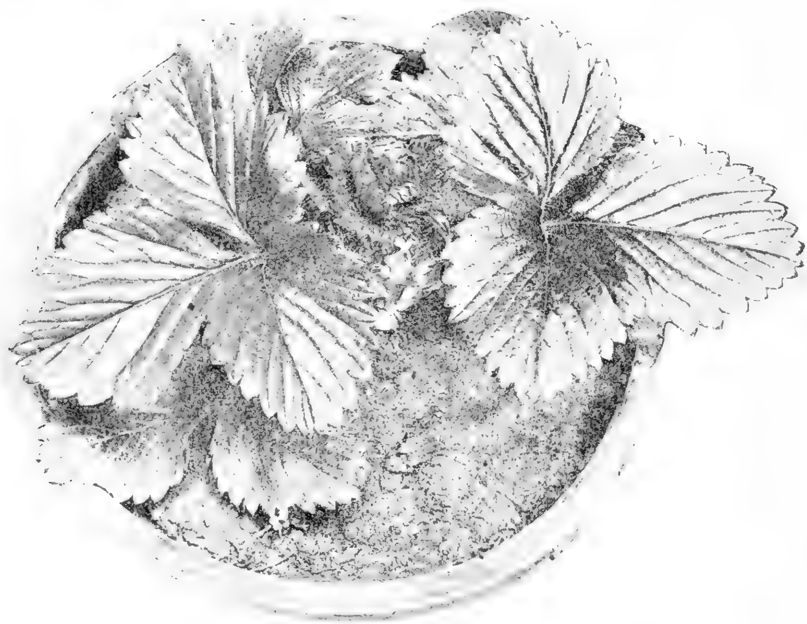

FIG. 3.—*Showing progress of plant in cool house.*

time. The accompanying cuts show habit of growth and, to an extent, the fruitfulness of this variety, although the first and largest berries had been picked from each plant before the photograph was made.

At this writing, it is considered that the three leading varieties for forcing are Glen Mary, Marshall and President, each possessing merits of its own.

GROWING THE PLANTS.

At the time of writing Bulletin 134, it was thought necessary to give the plants several shifts between the two-inch pot that was plunged to receive the runner and the fruiting pot; but it was soon found that with care in handling through the summer, one shift from the two-inch pot direct into the six-inch fruiting pot gave as good results as more frequent shifting. This saves the labor of at least two shifts, and allows root growth to continue uninterruptedly.

ROOTING THE RUNNERS AND HANDLING THE PLANTS.

The practice now is to plunge two inch-pots filled with rich soil along rows of virgin plants, *i. e.*, runners that were set early the same season which have never borne a crop of fruit. Then the first and strongest runners from these plants are led over the pots and as soon as they are well rooted and established in the pots they are cut off from the parent plant, the pots lifted and taken to a convenient place where the plants are at once shifted into the fruiting pots.

The Soil—At this final potting, a soil is used containing a large proportion of sandy fibrous loam. If not of light texture, sand should be added in the proportion of one to four. To this mixture is added a four-inch potful of dissolved rock or ground bone and a three-inch potful of muriate of potash to every four bushels of soil. Good drainage and firm potting are absolutely essential, and the latter is secured by using a potting stick to pack the soil in each pot.

FIG. 4.—*Illustrating a strong plant with good crown, ready for forcing.*

Treatment in the Cold Frame—After potting, the plants should be plunged to the rim in coal cinders or other cool material, and if protected by a frame will need less attention in watering than if unprotected. After plunging, water thoroughly once, then hold water from the pots as much as possible without allowing the soil to become entirely dry—until roots have well started from the first ball of roots —then water as needed until the pots have filled with roots. After this time, water but little, giving the plant the same general ripening period it has in the field, thus insuring a large "fat" crown filled with buds. On the approach of winter, protect from the first few sharp frosts; and when the plants become dormant, protect from snow until they are wanted in the house. Other things being equal, a plant that has a long period of rest and has been frozen hard will give better results when forced, although it is possible to obtain some good fruit from plants that have but a short rest. Only in the matter of one shift in place of three has economy in handling been found. Each successive stage needs great care and close attention.

FORCING THE PLANTS.

Care regarding temperature is of first importance through the entire growing season whether the plants are in beds or in pots. Starting with dormant plants taken from the cold frame, heat should be raised gradually from thirty to forty-five degrees by the end of the first week, increasing the heat until the plants are in bloom, when they should be growing in a temperature of from sixty to sixty-five degrees. From the time pollination begins, the house should range from sixty-five to seventy; and while the fruit is swelling, the heat should never be allowed to fall below seventy degrees. One of the accompanying cuts, Fig. 6, shows very clearly the necessity of heat to insure a crop.

THE MATURING PERIOD.

As to the length of time required to mature a crop of strawberries, the work carried on here leads to the conclusion that from eight to ten weeks are necessary for the best results, although the season may be hastened by hard forcing (pushing the crop) during the last four weeks. It is absolutely essential that the plants be grown slowly during the first half of the forcing period, allowing new roots and tops to form in about the same manner that they do throughout the spring weeks in the open. After root growth is well established, heat may be gradually increased and forcing hastened. If rapid forcing is the order, great care is necessary in the application of liquid manure, as the combined stimulus of excessive heat and quick-acting plant food has a tendency to develop soft, flavorless fruits. Heavy firing calls for high temperature and means danger of red spider, the one dreaded trouble of the forced strawberry. Daily syringing of the plants and frequent wetting of the walks must be resorted to in order to hold this enemy in check. It is always safer on this account to bring the crop along without undue haste, allowing the fruits to swell normally, retain their flavor and remain solid.

Influence of Temperature on Forcing—In order to test the question of temperature on forced strawberries, six plants of four varieties used for forcing in the winter of 1903–4, were placed on a bench in a carnation house where the temperature was held as near fifty-two degrees F. as possible. These plants, four each of Marshall, Glen Mary, Brandywine and Dunlap, were of the same stage of growth as the same varities that were given the usual forcing temperature, and had been grown and treated identically until the plants were in full bloom, when they were moved to the cool house, while the remainder of the plants were placed in the usual warm house. From that time

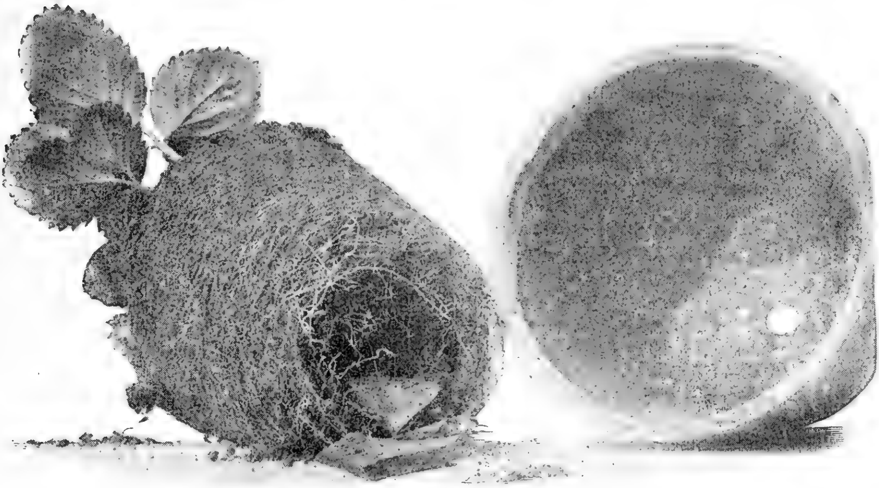

FIG. 5.—*Showing vigorous root system.*

until the berries on plants in the warm house were ready for market, the treatment of both lots was precisely the same with the exception of the temperature. This covered pollination, application of liquid manure and attention to spraying foliage when needed.

At the time the accompanying photograph, Fig. 6, was taken, three plants bearing an average number of fruits were selected from the two lots, growing one in the warm and the other in the cool house. In every case where fruit had set on the plants grown at the lower temperature, they were small and hard, only in a few instances growing to the size of an acorn, but uneven in form and poor in coloring. It may be of interest in this connection to say that while these plants were in this condition, a demand arose for a few pots of berries to be ripe in about four weeks' time; and these same plants among others were cleared of the immature fruits, taken to the warm house, plunged in soil that registered from seventy-five to eighty degrees, and in the required time were ripening from three to five fair sized berries to each plant. The experiment demonstrates that a cool temperature can be employed to retard strawberries, but comparatively high temperature is necessary to a regular normal development.

FIG. 6.—*Influence of temperature in forcing.*

LIST OF VARIETIES TESTED FOR FORCING.

Those marked with a double asterisk are the varieties considered the most profitable for forcing. Those with a single asterisk have a secondary value, and those without an asterisk are, in our experience, not suitable for forcing:

All Season's White
Anna Kennedy
Armstrong's Favorite
Aroma
Atlantic
Beder Wood*
Belle
Belle de Meaux
Bismarck
Brandywine
Bryant
Bubach*
Carrie
Challenge
Clyde
Commander
Dakota Iron Clad
Dunlap*
Edith
Enormous
Gandy
Gibson
Glen Mary**
Grosse Lombard
Hunn
Improved Parker Earle
James Perfection
Jersey Market
Johnson's Late
King Worthy
Lawrence
Laxton's Noble
Lehigh
Louis Gauthier
Luxury*
Lyons*
Mangoon
Manwell
Margaret
Marshall**
Marston
Maximus
Mexican
McKinley
Michel's Early
Michigan
Midnight
Miller
Minute Man
Monitor*
New Globe*
New York
Nick Ohmer
Ona
Palmer
Parker Earle
Parson's Beauty*
Patrick
Pet
Plow City
President**
Quality
Remontant Leon
Repeater
Ridgeway*
Rough Rider
Royal Sovereign
Ruby
Sample*
Sans Petite Rouge
Seaford
Sharpless*
St. Antone de Padrone
St. Joseph
Sutherland
Tice
Uncle Jim
Wm. Belt
Yant*
No. 171 Geneva Seedling
No. 173 Geneva Seedling
No. 177 Geneva Seedling
No. 47 Reasoner

FIG. 7.—*Approaching the ripening period.*

II

NOTES ON THE FORCING

OF

Tomatoes, Cucumbers and Melons.

TOMATOES.

The forcing of tomatoes, primarily as an aid in student instruction and incidentally as a test of varieties, is carried on each year at the Cornell Experiment Station greenhouses. The plants are set so that the crop is harvested between the holiday season and Easter week. Among the twelve or more varieties tested within the past four years, several desirable kinds have been found which are well adapted for forcing.

The characteristics of a good forcing variety are: slow, stocky growth; healthy, but not heavy, foliage; a habit of forming the first cluster of buds near the base of the plant. Each flower should have a protruding stigma, thus being able to set fruit with a minimum amount of pollen; and it should bear fruit of medium size and uniform shape. The size and shape are of the utmost importance.

Winter tomatoes as a vegetable are high-priced, but hardly rank as a luxury, selling as they do from twenty to forty cents a pound. As a single fruit is usually served to each guest, if the fruits are large, the cost is considerably increased; and if irregular, the appearance of the dish would be unattractive. The consumer orders a definite number of fruits rather than a specific weight; and in supplying a critical market, it is necessary to have the tomatoes of moderate size and as nearly uniform as possible.

Remarks on Varieties—In many respects, the English types of tomatoes have proved to be superior for forcing purposes to those of American origin. They set fruit more readily in dark weather; they grow the fruit in clusters, ripening the full cluster within a short period, and continue in growth considerably longer than American types. However, there are a few of the latter varieties that have proved highly satisfactory as forcing varieties. Lorillard, one of the first of the American varieties to be forced for midwinter crops, is still as extensively grown as any other variety; and when the true variety is obtained, it is a fine forcing tomato. Combination (American), a variety that came into prominence about six years ago, has given good satisfaction. Mayflower, but for the habit of ripening fruits slowly and separately, would fill all requirements. Pepper (American), a variety with more of the general characteristics of the English tomato than of the American type, has proved an excellent late winter and early spring variety. Fruit of this variety is oblong rather than round. It is borne in large clusters. The fruit ripens evenly, and the only objection to it is its small size. It is a little too small for a fancy trade, in which respect the Sterling Castle, an excellent English variety, is also deficient.

Perhaps the four best varieties for general midwinter forcing are Lorillard and Combination (American), Frogmore and Holmes' Supreme (English). Others of secondary excellence are Sterling Castle (English), and Pepper (American). Both of these varieties have given good results in late winter when the fruits were thinned to the extent of removing about half of that which set under favorable conditions. Other varieties of promise are Eclipse, Spark's Earliana and Lester's Prolific.

FIG. 8.—*Size as a marketing factor.*

ENEMIES.

Diseases—In the forcing of Tomatoes at Cornell Experiment Station, there has been for several years exceptional freedom from disease. Last winter, however, our floor beds were given a copious watering preceding a week of cloudy cold weather, when it was impossible to adequately ventilate or dry out the houses. This appears to have brought on an obscure trouble which caused the yellowing and spotting of the leaves, resulting finally in a decided check to the plants. On the return of clear and warmer weather, the houses and the soil lost a large amount of moisture and the plants recovered to a certain extent, but were in poor condition to bear heavy crops. Nothing in the way of bacterial or fungous growth could be discovered, and the trouble no doubt was a physiological disturbance due to heavy watering following a period of rapid growth, accompanied by cold cloudy weather.

Insect Enemies—Controlled by Fumigating. In common with the experience of many other growers, the houses have been for several years infested with white fly (Aleyrodes). This insect has caused much anxiety to the grower of plants under glass, and many attempts have been made to exterminate the pest by commercial grower and experiment station. Spraying with soap solutions and fumigating with various tobacco preparations were thoroughly

FIG. 9.—*Forcing in ground bed.*

tested in the Cornell forcing houses, but with no lasting benefit, and finally fumigation with hydrocyanic acid gas was resorted to, using potassium cyanide ninety-eight per cent strength, and commercial sulphuric acid sixty-six per cent and a small quantity of water. Many trials were made with this gas, varying the amounts of cyanide, the time of exposure, the temperature and humidity of the houses. In some instances, there was injury to foliage without destruction of the insects; and especially was this true when fumigation was made in daylight, or when the houses were very damp. Short time fumigation with from two to four ounces of cyanide per thousand cubic feet of space, was found unsafe; and long time or overnight fumigation with one ounce of cyanide to each one thousand cubic feet, was safe only under certain conditions. These conditions, in our experience, are absolute darkness, a still air, a temperature below sixty, and a dry house. With these conditions, it has been possible to keep down the Aleyrode by fumigating once each month with one ounce of cyanide of potassium, two ounces of sulphuric acid and four ounces of water to each one thousand cubic feet of house space.

Great care is necessary in the use of this gas. No part of the handling must be left to chance. Not only should the house in which the gas is generated be locked, but the entire range should be guarded. The gas may escape from one house to the next and is sure death to all animal life.

FIG. 10.—*Pepper. Desirable for late winter and early spring.*

How to Fumigate—A desirable method is to fumigate late in the evening when there is less likelihood of anyone being in, or around the houses. Our practice is to measure the four fluid ounces of water into earthenware vessels. Then measure the acid and pour into the water. Weigh the cyanide and place in thin paper bags. Set the vessel containing the liquid on walks in house. Drop a bag of cyanide in the vessel and walk briskly out of the house. If more than one vessel is used (and in a house containing five thousand cubic feet, two vessels are better), the second bag of cyanide may be dropped in passing, starting with the one farthest from the door. If this fumigation is made before midnight, it might be safe to enter the house next morning in order to raise the ventilators; but it would be better to open them from outside, if possible, thus taking no risk.

Various trials made—Fumigations made in full daylight, using two, three and four ounces of cyanide to each one thousand cubic feet of space for twenty minutes, the temperature of the house ranging from seventy to eighty degrees, resulted in slight injury to the foliage of tomatoes and severe injury to the foliage of chrysanthemums, geraniums and begonias.

Two ounces of cyanide for two hours, house at sixty-five degrees, but damp; exposure made at six p. m.; injury to chrysanthemums

FIG. 11.—*Lester's Prolific tomato, an excellent winter variety.*

not serious. Under these conditions and using the same amount resulted in quite serious injury to tomatoes.

Two ounces cyanide, temperature sixty degrees, with dry atmosphere and all-night exposure resulted in very slight injury to cucumber vines and the destruction of over ninety per cent of the insects (white fly). One ounce cyanide, house dry, sixty degrees or below, dark, no injury at any fumigation. Insects mostly killed.

HINTS ON FORCING MELONS AND CUCUMBERS.

I. Melons.

Melons and cucumbers have been grown with uniform success for a number of winters past at the Cornell Forcing-Houses. One house has been devoted each winter to the muskmelon, a very difficult winter crop, needing constant care through all stages of growth. This is a crop that should perhaps be called a private gardeners' crop rather than a commercial crop. The time needed to mature a crop is approximately six months, and the attention and heat necessary, make the resulting crop a very expensive one, costing perhaps as much as one dollar per fruit, with a so-called full crop.

Melons, unlike cucumbers, are ripened on the vine, not picked green, and considerable time as well as skill is required to bring both the vine and fruit to maturity gradually and together. There are two types employed in forcing, English and American. The English type has been found the better, probably for the reason that these varieties have been selected for years for this purpose.

Varieties—Among the best varieties of muskmelon for forcing are Blenheim Orange, Invincible Scarlet, Monroe's Little Heath, Hero of Lockinge and Gilbert's Green Flesh. The Blenheim Orange is an exceptionally fine flavored melon, setting fruits with ease; it is perhaps the best on the list.

Requirements of the crop—Melons need full sunlight, therefore the glass is not shaded and, in consequence, great care must be taken in watering and keeping the house damp at all times, except during the period of pollination, when the houses should be held rather dry. Hand-pollination is necessary, and it should be deferred until the main vines have reached the desired length with vigorous-growing laterals, well set with pistillate flowers. This, then, is the time to set all the fruit wanted at the same time. Melons are peculiar in that if one fruit gets possession of the vine and grows to any considerable size, it is difficult if not impossible to set other fruits afterwards on the same vine. When four to six fruits set on each vine, the crop may be considered as above the average. After the setting, the plants will need attention only in the matter of providing supports for the fruits so that they may hold a healthy growth of foliage and feeding.

Feeding—Liquid cow or sheep manure usually gives quickest results, and an application of either should be made each week as the fruit is swelling. When the surface of the fruit begins to "net" (roughen) stimulating foods and water should be withheld, the houses allowed to dry gradually; and as the fruits continue to ripen, the vines should follow closely in degree of maturity, so that when the last fruit on a vine is picked the vine is ready to be thrown out.

A succession of plants may be grown, but the setting of young plants between old fruiting plants is attended by many difficulties, for the young plants need entirely different treatment from that required by the older vines; and it is always more satisfactory to clear out the house at one time and clean it thoroughly before a new crop is started.

II. FORCING CUCUMBERS.

Cucumbers are now forced in considerable quantity for the New York and Boston markets, to a less degree perhaps for the other leading markets of the country. Many of these forced crops are passing from the position of luxuries to that of necessities. The forcing of cucumbers is an older industry in New England than is ordinarily supposed. The English varieties grown at Cornell and mentioned below are not cultivated; they are not profitable.

A. THE BEGINNING OF CUCUMBER FORCING IN NEW ENGLAND.

The following interesting note on the forcing of cucumbers in Massachusetts is contributed by Dr. Jabez Fisher, of Fitchburg, Mass.: "As near as I can recall, my experience with cucumber growing is as follows:

"In the spring of 1860, I built a small glass house, and in 1861 extended it to 105 feet in length; width, 18½ feet; double span, running north and south, and with double glazing enclosing an air space of one and one-half inches. It was built for forcing grapes (V. vinifera) in large pots, and strawberries in six-inch pots. In 1862 a single cucumber, self-sown, came up in the central bed, which looked so promising that I had not the heart to destroy it, and placed a stake by the side of it and trained it up to the top of the house, about seven feet. Along with strawberries sent to Boston market, I sent at four different times in all twelve cucumbers which sold for \$3.08 net. This was a new idea, and I kept it in sight. In December, 1863, the grapes proving unsatisfactory, I planted a few cucumbers, the product of which was 1421 lbs., bringing \$325.61. These were sold to William Taylor, of New York, who, I think, was a rival of Delmonico. Later crops were sold to Taylor, and Archdeacon & Canty, now Archdeacon & Co., of New York, and also in part in Boston.

"The variety of cucumber grown was mostly the New Jersey Hybrid, a cross between the old White Spine and one of the longer English varieties. It produced a fruit about ten to twelve inches long, weighing about three-fourths of a pound. In 1865, the product

FIG. 12.—*Eclipse. A new forcing tomato of merit.*

was \$460.97; in 1866, \$688.92; in 1867, \$746.18. (This same year I contracted with Wm. Taylor to supply strawberries at \$9.00 per quart in February, \$7.00 in March, and \$5.00 in April.) In 1868 the cucumbers brought \$1092.52, and I decided to give up strawberries as I had grapes several years before, and grow cucumbers only. In 1869, the cucumber crop sold for \$1,588.88. This has not been equalled since. In 1875, the crop was partly New Jersey Hybrid and partly White Spine, since which the latter only has been grown.

"In the first years, cucumbers were not wanted earlier than March 1st and some years they sold on commission for but twelve cents in January and seventy-five cents in March and April; once for more than a dollar each.

"I had many visitors attracted by the experiment, but no competitor for some ten years, when, as a direct result of my showing, Mr. G. M. Kendall, of Leominster, started in that town, and Mr. T. L. Hosmer in Baldwinsville, both of which localities are now very large producers of winter cucumbers. In a less degree, the business has spread elsewhere; and spring crops, following lettuce, about Boston and other places have become a very large business."

FIG. 13.—*A productive stem of pepper tomato.*

B. COMMERCIAL METHODS.

The following questions were submitted to Mr. G. M. Kendall, of Leominster, Mass., a veteran grower of cucumbers under glass, and one who has made a great commercial success of the business. Mr. Kendall's answers are of great value to those in the business and those interested:

1. What is the usual time of starting the commercial crop?

Answer. The time of starting the "cuke" plants depends on the time you want them. Cukes, of late years, do so badly out of doors that the gardeners are raising them in the greenhouses all the year through. They are ready to gather two months from the time the seed is sown.

2. What are your preferences in regard to soil?

Answer. The best soil to grow "cukes" in, is a sandy loam, with plenty of good, fresh horse manure,—say about one-third manure. I have grown good cukes in clear sand and horse manure.

3. What is the method of pollinating flowers?

Answer. The method of pollinating the flowers is one of Nature's own and the best I know of, viz., by the use of bees; but I have done it by hand with good success. A man will pollinate about five hundred flowers in one hour after he gets used to it. When bees are employed, I use one male to about six female blossoms.

4. What is the method of training and pruning vines?

Answer. I train the vine up to about ten feet and then nip off the head from the main vine; but I also nip off every lateral at the first joint beyond the cuke. I also keep all joints clean—say about twenty inches from the ground.

5. How packed and marketed?

Answer. I pack all cukes in bushel boxes containing ninety-six cukes, and put on a tight cover to keep all air from them. I send them to any good reliable commission house, and pay about ten per cent for selling.

6. What varieties are grown?

Answer. The variety I grow is some kind of White Spine. Almost every man has a kind of his own. Mine are well-bred White Spine, the purer the better.

7. What is the temperature maintained in the house?

Answer. The temperature in the house should be about sixty-five degrees at night, and ninety to one hundred degrees in good sunshiny days.

8. Remarks on construction of cucumber houses.

Answer. The plans for a good cuke house would be to build it twenty-three feet wide and two hundred feet long; solid bed in center, ten feet wide; and raised bed each side about four feet wide, with pipes for heating under the side beds.

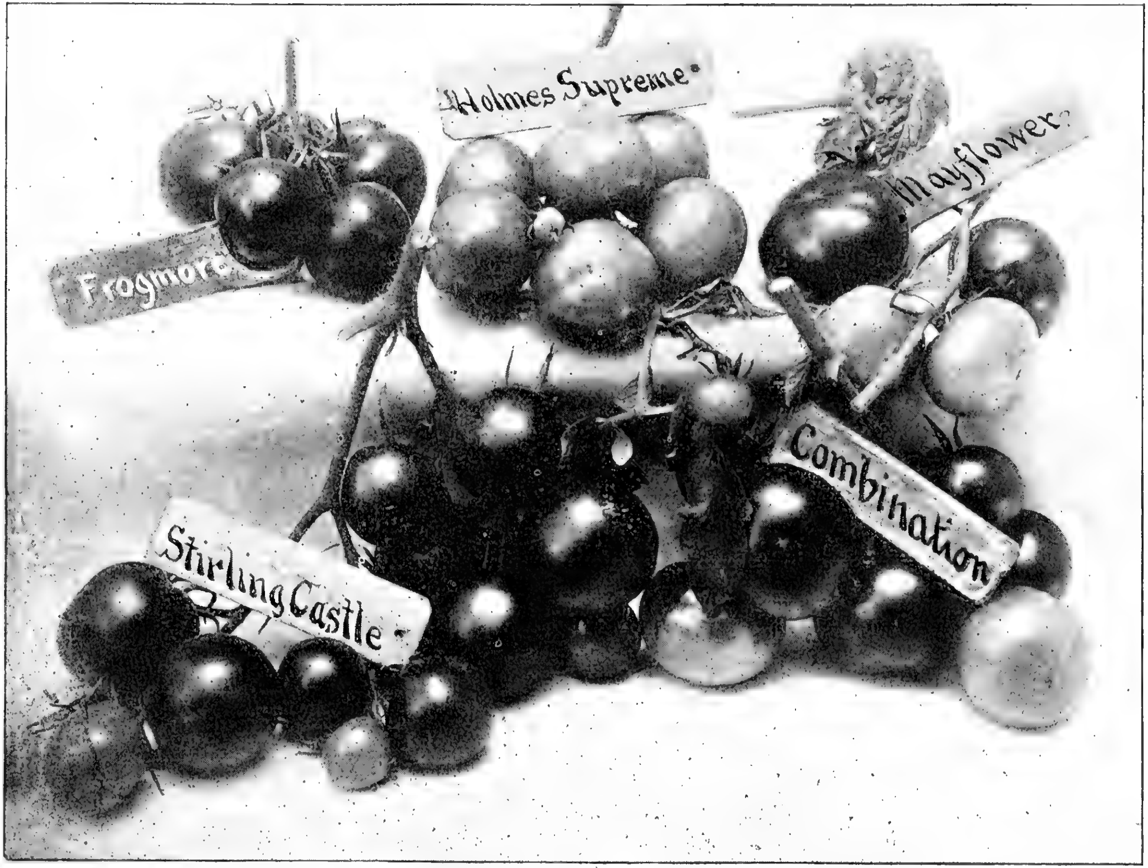

FIG. 14.—*A group of standard forcing tomatoes.*

C. FORCING ENGLISH CUCUMBERS.

The work with cucumbers at Cornell forcing houses has been almost entirely with those of the English type. These are the long, slim varieties growing often from eighteen to twenty-four inches in length, very regular in shape, crisp and delicate in flavor. This type of cucumber should be grown in shaded houses, the large succulent leaves burning if exposed to full sunlight. This shading of the house makes pollination rather difficult unless the house is held

FIG. 15.—*Great commercial house of G. M. Kendall.*

dry through the middle of the day while fruit is being set. On the other hand over-dryness encourages red spider. Cucumbers are picked green, usually before they have reached their full growth; in consequence the vines may be maintained in full vigor and in fruiting condition for an almost indefinite period if plants are healthy and food is furnished in sufficient quantity. The culture of this crop is, with the exception of a shaded house, similar to that of growing melons.

Among the varieties tested, Duke of Edinburgh, Rollinson's Telegraph, Lockies Perfection, Covent Garden and Lion House Improved are considered the best kinds for forcing in this locality.

Fig. 16.—*English cucumbers in Cornell University forcing house.*

III. NOTES ON THE CULTURE OF CUCUMBERS AND MELONS.

In sowing seeds of cucumbers or melons, it is quite important that they be sown in small pots, pieces of sod or other material that will hold its shape and not allow the soil to break away from the roots when transplanted. In sowing in pots, a soil composed of equal parts of loam, leaf mould and sand is used. Two seeds are sown in each three-inch pot. These pots are then plunged in soil or sand on a warm bench and thoroughly watered. In from two to four weeks the plants should be large enough to plant out on the benches. They should be pushed along rapidly and not receive any check at any time through low temperature or neglect.

The Bench—It is the usual practice to entirely fill the bench with soil and set the plants two feet each way in benches filled with soil composed of fibrous loam with at least one-third sharp sand or good gravel added. To this should be added well-rotted manure, at the rate of one bushel to six of loam; and a four-inch pot of ground bone or dissolved rock is also well mixed with each six bushels of soil. Commercial growers are very much more lavish in the use of manure. They often use a soil half loam and half manure, and enrich this as the crop develops.

In setting the plants in the bed, some soil is removed from the place where the plant is to be set, a large handful of sharp sand is scattered in the hole, the plant then set and sand again used to fill up to the stem of the plant, firming the soil well around the sand. This sand is used to avoid, as far as possible, the serious trouble called "damping off." This fungus attacks the plants after they have attained some size, often when in fruit, and is encouraged by over-moist condition directly around the stem of the plant. Previous to this use of sand, quite a number of plants were lost each year through this trouble; but since setting each plant in sand, no plants have been lost.

Training—It is the general practice to train the vines upward rather than allow them to spread over the soil on the benches, and for this purpose wires are stretched lengthwise on the bench. These are connected by smaller wires or strings running from the lower to the upper wire. To these, the plants are tied, using raffia or soft twine. Usually one main vine or leader is allowed to grow to the desired height, the tip then pinched back and two or more laterals started, these to be also tied as they grow. It is usually better to wait until the vines have made a good strong growth before attempting to set fruits, as the fruits grow very rapidly and will often check the plants if allowed to set too early. After fruits are swelling, it will be necessary to furnish them some support to prevent the breaking down of the vine. In the case of English cucumbers, this may be done by making a sling of raffia with which to support the fruits. Melons may be rested upon a thin board slung by strings attached to each corner and suspended to a wire overhead.

C. E. HUNN,
JOHN CRAIG.

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CORNELL UNIVERSITY

AGRICULTURAL EXPERIMENT STATION OF THE COLLEGE OF AGRICULTURE

Department of Agronomy

EXPERIMENTS ON THE INFLUENCES OF FERTILIZERS UPON THE YIELD OF TIMOTHY HAY WHEN GROWN ON DUNKIRK CLAY LOAM IN TOMPKINS COUNTY, NEW YORK.

Made under the direction of Thomas F. Hunt.

By JOHN W. GILMORE and SAMUEL FRASER.

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EXPERIMENTS ON THE INFLUENCE OF FERTILIZERS UPON THE YIELD OF TIMOTHY HAY WHEN GROWN ON DUNKIRK CLAY LOAM IN TOMPKINS COUNTY, N. Y.

The census for 1900 gives the area in meadows approximately one-third the area of the improved land in the State. All other cultivated crops are reported to occupy an equal area, leaving one-third the improved area unaccounted for but presumably in pasture. Thirty-one per cent of the area in farm in New York State is unimproved. Presumably much of this unimproved area is in woodland and doubtless some is pastured. The hay and forage crops of New York State in 1900 constituted nearly two-fifths of the value of all of the crops, not including pasture, produced in the State; and between one-ninth and one-eighth of the value of the hay and forage crops of the United States. It is evident from the above statistical evidence that grass is an important crop in New York State. It has become so because of the natural adaptability of the climate and soil to the growth of grass and not because of, but in spite of, economic conditions.

The Agricultural Experiment Station of Cornell University began two years ago a rather systematic study of the grasses and forage crops. Considerable data has already been accumulated bearing upon the general problem of the development of pastures and meadows of the State. The following report of progress has been selected for publication at this time because the marked influence of fertilizers containing nitrogen suggests the importance of more extended trials by farmers themselves of commercial fertilizers containing nitrogen. If such trials should prove the results here reported to have a wide application in the State they would further emphasize the importance of the "quest for nitrogen" by means of leguminous crops and by the preserving of stable manure, and particularly emphasize the importance of absorbing the liquid excrements, which contain the bulk of the nitrogen excreted, by the use of bedding and other absorbents. It is assumed that this experiment will be applicable to other regions in Central New York and perhaps the whole State where the same-soil type occurs. It is probable that there are other types of soil on which the same results may not be obtained

THE SOIL.

According to the Bureau of Soils, United States Department of Agriculture, the Dunkirk series forms an important group of soils and are "found in well-defined terraces along some of the great lakes. These soils are composed of glacial material reworked and redeposited when the lake waters reached a higher level than at present."

The Dunkirk clay, the most tenacious type of this series, is described as follows: "Soil is a dark to black clay, six to twelve inches in depth, underlain by a tenacious, mottled clay, beneath which, at a depth of four to ten feet, occurs the typical bowlder clay. Near ancient beach lines the soil is sometimes underlain by gravel. Found upon lake foreland and in upland valleys. Derived from deposition in quiet water. Some areas badly drained." As this type occurs on the Station farm it is generally lighter in color than the description above given, only appearing black in the ravines and lower areas, and none of the black phase occurred in the tract on which this experiment was conducted. The soil is quite tenacious and is difficult to work except when moisture conditions are just right. It is usually difficult to get upon this land until late in the spring, and early fall rains may prevent fall seeding.

A mechanical analysis of the soil upon which the following experiments were conducted was made by the Bureau of Soils with the following results:

MECHANICAL ANALYSIS OF DUNKIRK CLAY LOAM, CORNELL UNIVERSITY FARM.

CONVENTIONAL NAMES.	Soil.	Subsoil.
Organic matter	2.6	0.6
Fine gravel, coarse and medium sand	2.3	1.4
Fine and very fine sand	9.6	6.7
Silt	64.2	56.6
Clay	23.9	35.2
Total (not including organic matter)	100	99.9

This analysis gives the percentage of silt much higher, and the percentage of clay much lower than the analyses reported for Dunkirk clay. It is thought advisable, therefore, to classify this soil as the silty phase of Dunkirk Clay Loam, no description of which has been given.

The tract on which this experiment was conducted had come only recently into the possession of Cornell University. The former management had been such as to reduce somewhat, although not seriously, its crop producing power. It is well adapted to the growth of timothy; fairly well adapted to the production of wheat, when properly fertilized; and is less valuable for the production of maize and potatoes. A sample was taken from each of the four corners of the tract under consideration and analyzed by Dr. J. A. Bizzell under the direction of Professor George W. Cavanaugh, with the following results:

MINERAL CONSTITUENTS IN DUNKIRK CLAY LOAM, CORNELL UNIVERSITY.

PER CENT IN WATER FREE SUBSTANCE OF FINE EARTH:

Phosphoric acid	0.158
Potash	0.293
Lime	0.214
Magnesium	0.66

The percentages of mineral constituents above given are such as are usually found in soils of average fertility. The tract had been in oats in 1903, the year previous to this experiment.

In 1902 a crop of corn was taken from the land. The yield, while average for this type of soil, was not equal to the average upon types better adapted to corn. After the corn crop was taken from the land some remnants of fertilizers were distributed upon the land adjoining and the application extended about 20 feet upon the north ends of these plats. The residual effect of this fertilizer was manifest in the timothy, but as the application extended uniformly upon all plats the relative yields were not affected.

EXPERIMENT WITH OATS.

This experiment was begun in the fall of 1903. The plan was to seed to wheat and timothy that fall, with the primary object of determining the influence of fertilizers upon the yield of timothy hay, the introduction of wheat into the experiment being merely in order to make it conform with usual farm practice. The plats were subsequently plowed on August 23-25, and fitted on Sept. 13, 1903. The north half of each plat was limed with slaked lime on Sept. 15, and the fertilizers applied as shown in the following table on Sept. 16. The plats were 226.5 feet long and 19.25 feet wide, making an area of one-tenth acre. This width was chosen because it is the distance covered by three courses of the drill. Between each plat a space of two feet intervened, which was not seeded, but kept cultivated.

FERTILIZERS ON OATS AND TIMOTHY.

Plat No.	Fertilizing Materials. Rates per acre. Nitrate Soda.	Acid Phosphate.	Muriate Potash.	Total.	Fertilizing Constituents. Rates per acre. Nitrogen (N).	Phosphoric acid (P_2O_5.)	Potash.	Cost of fertilizers.
	Lb.	Lb.	Lb.	Lb.	Lb.	Lb.	Lb.	
712......	......	320	......	320	....	50	......	$1.60
713......	......	....	80	80	....	....	40	1.60
715......	160	....	......	160	25	....	......	3.60
716......	160	320	......	480	25	50	......	5.20
718......	......	320	80	400	....	50	40	3.20
719......	160	....	80	240	25	....	40	5.20
721......	160	320	80	560	25	50	40	6.80
722......	160	640	80	880	25	100	40	8.40
724......	320	640	80	1,040	50	100	40	12.00
725......	320	320	80	720	50	50	40	10.40
727......	160	320	80	560	25	50	40	6.80
728......	A	320	80	560	*	50	40	*
731......	B	....	......	......	....	....	......	5.00
732......	C	....	......	......	....	....	......	10.00

A. 160 lb. "Niterlime." Not applied in 1905.
B. 10 tons of manure.
C. 20 tons of manure.
*The quantitative composition of "Niterlime" was not determined, therefore no valuation can be ascribed to this ingredient.

The acid phosphate was valued at ½c. a lb. or $10 per ton.
The nitrate of soda was valued at 2¼c. a lb. or $45 per ton.
The muriate of potash was valued at 2c. a lb. or $40 per ton.
The stable manure was valued at 50c. per ton.

Early fall rains prevented the seeding of wheat on this tenacious clay soil. It was, therefore, decided to sow oats in the spring without the application of any further fertilizer. The plats were sown to oats at the rate of nine pecks per acre on April 18, 1904, together with timothy at the rate of fifteen pounds per acre.

YIELDS OF OATS IN 1904.

The following table gives the yield of grain in bushels per acre, the increased yield due to treatment, the total value of increase, and the net gain or loss from fertilizers. The yield of straw is not given, since some doubt as to the accuracy of the figures has arisen. The value of the increased yield of oats is obtained by multiplying the number of bushels by 34 cents, which is according to the United States Department of Agriculture, the average December price of oats in this State for the ten years ending 1903. The net gain or loss from fertilizer is obtained by subtracting from the total value of the increase the cost of the fertilizer, as shown in table on page 279.

INFLUENCE OF FERTILIZERS UPON THE YIELD OF OATS ON DUNKIRK CLAY LOAM IN 1904.

Plat No.	TREATMENT.	Bu. oats per acre.	Increased yield of grain bu.	Total value of increase.	Net gain or loss (—) from fertilizer.
711	No treatment	56.2	....	....	....
712	320 lbs. Acid Phosphate	53.4	—3.6	$—1.22	$—2.82
713	80 lbs. Muriate Potash	50.6	—7.2	—2.45	—4.05
714	No treatment	58.6	....	....	....
715	160 lbs. Nitrate Soda	63.5	4.5	1.53	—2.07
716	320 lbs. Acid Phosphate 160 lbs. Nitrate Soda	65.6	6.2	2.11	—3.09
717	No treatment	59.7	....	....	....
718	320 lbs. Acid Phosphate 80 lbs. Muriate Potash	65.4	6.5	2.21	— .99
719	160 lbs. Nitrate Soda 80 lbs. Muriate Potash	68.3	10.2	3.49	—1.73
720	No treatment	57.4	....	....	....
721	160 lbs. Nitrate Soda 80 lbs. Muriate Potash 320 lbs. Acid Phosphate	64.9	9.4	3.20	—3.60
722	160 lbs. Nitrate Soda 80 lbs. Muriate Potash 640 lbs. Acid Phosphate	60.7	7.1	2.41	—5.99
723	No treatment	51.7	....	....	....
724	320 lbs. Nitrate Soda 80 lbs. Muriate Potash 640 lbs. Acid Phosphate	62.8	12.	4.08	—7.92
725	320 lbs. Nitrate Soda 80 lbs. Muriate Potash 320 lbs. Acid Phosphate	60.2	10.3	3.50	—6.90
726	No treatment	49.	....	....	....
727	160 lbs. Nitrate Soda 80 lbs. Muriate Potash 320 lbs. Acid Phosphate	53.8	4.6	1.56	—5.24
728	160 lbs. "Niterlime" 80 lbs. Muriate Potash 320 lbs. Acid Phosphate	51.5	2.1	.71	*
729	No treatment	49.7	....	....	....
730	No treatment	48.1	....	....	....
731	10 tons of manure	54.2	5.3	1.80	—3.20
732	20 tons of manure	60.1	11.2	3.81	—6.19

As before stated, this experiment was not planned primarily to observe the influence of fertilizers upon the yield of oats, but to study the influence of fertilizers upon the yield of timothy hay. The question was as to the subsequent influence of fertilizers in the production of timothy hay. However, the increase or decrease in yield of oats enters into the final problem. Two circumstances conspire to make the fertilizers less effective probably than normally in increasing the yield of oats, namely, (1) the fertilizers were applied in the previous year for reasons heretofore explained*; and (2) the seasonal conditions were favorable to a high yield of oats upon the untreated plats. The oat crop is known as a weather crop, that is to say, the crop is sensitive to the temperature and moisture conditions during the growing season, and if these are just right the soil is relatively less important. The residual influence of stable manure was quite marked upon the timothy hay, although it did not greatly increase the yield of oats. In no case did the increase in the yield of oats pay for the cost of the fertilizer applied, and on two plats where only mineral fertilizers were applied there was a decrease in yield.

YIELD OF TIMOTHY HAY IN 1905.

After the removal of oats in 1904 nothing was done to the plats until April 5th, when each plat was fertilized as indicated in the table on page 279 except Plat 728, which received all fertilizers designated except "Niterlime." Plats 731 and 732, which had received 10 and 20 tons of stable manure respectively in 1903, were left untreated in 1905. On July 7, 1905, the timothy was mown, and on July 12, 1905, the hay was weighed. The following table gives the yields of hay per acre, the increased yield of hay due to treatment, total value of the increase, and the net gain or loss from fertilizers. The total value of the increase is obtained by multiplying the increase in yield in tons by $10.60. This, according to the United States Department of Agriculture, is the average December farm price of hay in New York State for the ten years ending 1903. The net gain or loss from fertilizers is obtained by subtracting from the total value of the increase the cost of the fertilizers, as shown in table on page 281.

*See note page 278.

INFLUENCE OF FERTILIZERS UPON THE YIELD OF TIMOTHY HAY ON DUNKIRK CLAY LOAM IN 1905.

Plat No.	TREATMENT.	Yield of hay per acre lb.	Increase in yield of hay lb.	Total value of increase.	Net gain or loss (—) from fertilizers.
711	No treatment	1,910	....	....	....
712	320 lbs. Acid Phosphate	2,680	607	$3.21	$1.61
713	80 lbs. Muriate Potash	3,190	954	5.05	3.45
714	No treatment	2,400	....	....	....
715	160 lbs. Nitrate of Soda	3,550	1,216	6.44	2.84
716	320 lbs. Acid Phosphate 160 lbs. Nitrate Soda	3,840	1,573	8.34	3.14
717	No treatment	2,200	....	....	....
718	320 lbs. Acid Phosphate 80 lbs. Muriate Potash	2,800	510	2.70	— 50
719	160 lbs. Nitrate Soda 80 lbs. Muriate Potash	4,280	1,900	10.07	4.87
720	No treatment	2,470	....	....	....
721	160 lbs. Nitrate Soda 80 lbs. Muriate Potash. 320 lbs. Acid Phosphate	4,590	1,877	9.95	3.15
722	160 lbs. Nitrate Soda 80 lbs. Muriate Potash 640 lbs. Acid Phosphate	4,350	1,394	7.39	—1.01
723	No treatment	3,200	....	....	....
724	320 lbs. Nitrate Soda 80 lbs. Muriate Potash 640 lbs. Acid Phosphate	5,880	3,044	16.13	4.13
725	320 lbs. Nitrate Soda 80 lbs. Muriate Potash 320 lbs. Acid Phosphate	6,610	4,137	21.93	11.53
726	No treatment	2,110	....	....	....
727	160 lbs. Nitrate Soda 80 lbs. Muriate Potash 320 lbs. Acid Phosphate	4,310	2,380	12.61	5.81
728	160 lbs. "Niterlime"† 80 lbs. Muriate Potash 320 lbs. Acid Phosphate	2,470	720	3.82	*
729	No treatment	1,570	....	....	....
730	No treatment	1,420	....	....	....
731	10 tons of manure	4,090	2,595	13.75	13.75
732	20 tons of manure	5,520	4,025	21.33	21.33

*See page 278.

†"Niterlime" not applied in 1905.

FINANCIAL RESULTS FROM FERTILIZERS WITH OATS AND TIMOTHY HAY.

No table can be constructed which will show accurately the financial returns which may be obtained from the fertilizers used, since the residual effect of the fertilizers is in some cases undoubtedly considerable. In the following table, however, the net gain or loss from fertilizers with the oats and with the timothy has been combined in order that the reader may understand the status of the experiment up to date from a financial point of view:

NET GAIN OR LOSS FROM FERTILIZERS WITH OATS AND TIMOTHY HAY.

Plat No.	TREATMENT.	Net gain or loss (—) from fertilizer with oats.	Net gain or loss (—) from fertilizer with timothy.	Net gain or loss (—) from fertilizer with both crops.
711	No treatment	....	....	....
712	320 lbs. Acid Phosphate	—$2.82	$1.61	—$1.21
713	80 lbs. Muriate Potash	—4.05	3.45	— 60
714	No treatment	....	....	....
715	160 lbs. Nitrate Soda	—2.07	2.84	77
716	320 lbs. Acid Phosphate 160 lbs. Nitrate Soda	—3.09	3.14	05
717	No treatment	....	....	....
718	320 lbs. Acid Phosphate 80 lbs. Muriate Potash	—.99	— 50	—1.49
719	160 lbs. Nitrate Soda 80 lbs. Muriate Potash	—1.73	4.87	3.14
720	No treatment	....	....	....
721	160 lbs. Nitrate Soda 80 lbs. Muriate Potash 320 lbs. Acid Phosphate	—3.60	3.15	— 45
722	160 lbs. Nitrate Soda 80 lbs. Muriate Potash 640 lbs. Acid Phosphate	—5.99	—1.01	—7.00
723	No treatment	....	....	....
724	320 lbs. Nitrate Soda 80 lbs. Muriate Potash 640 lbs. Acid Phosphate	—7.92	4.13	—3.79
725	320 lbs. Nitrate Soda 80 lbs. Muriate Potash 320 lbs. Acid Phosphate	—6.90	11.53	4.63
726	No treatment	....	....	....
727	160 lbs. Nitrate Soda 80 lbs. Muriate Potash 320 lbs. Acid Phosphate	—5.24	5.81	57
728	160 lbs. "Niterlime" 80 lbs. Muriate Potash 320 lbs. Acid Phosphate	*	*	*
729	No treatment	....	....	....
730	No treatment	....	....	....
731	10 tons of manure	—3.20	13.75	10.55
732	20 tons of manure	—6.19	21.33	15.14

*See note pages 278 and 281.

The most important result as shown, both in the growing crop and in the weights of hay, was the influence of the nitrate of soda. In every instance where nitrate of soda was applied a marked increase in the vigor of growth as well as in the weight of hay was produced. The influence of the phosphoric acid and potash was much less marked in all instances. When nitrate of soda was doubled without increasing the acid phosphate or the muriate of potash the apparent increase in yield was more than doubled, but when the phosphoric acid was doubled without increasing the nitrate of soda or the muriate of potash the yield was decreased. The results suggest that the relation of nitrogen to mineral salts is a matter of importance on Dunkirk clay loam. They suggest that 320 pounds of acid phosphate to 160 pounds of nitrate of soda, or 620 pounds of acid phosphate to 320 pounds of nitrate of soda is too much, since 320 pounds of nitrate of soda in connection with 320 pounds of acid phosphate brought better results than either of the above combinations. Perhaps more economical results would have been obtained if only 160 pounds of acid phosphate had been used with 160 pounds of nitrate of soda in Plat 721. It would seem that muriate of potash increases the total yield of hay. The alsike clover was especially abundant all over Plats 713 and 718 which received muriate of potash without receiving nitrate of soda. The plats which received nitrate of soda in addition to muriate of potash, either with or without acid phosphate, con-

714	713	712
No treatment.	80 lbs. Muriate Potash.	320 lbs. Acid Phosphate.
2400 lbs. hay per a.	3190 lbs. hay per a.	2680 lbs. hay per a.

FIG. 17.—*The growth upon these plats was rather short and of fine texture. Considerable alsike clover grew on plat* 713.

tained much less alsike clover, and this chiefly at the north end of the plats, while those plats which did not receive muriate of potash contained practically no alsike clover except plats which received stable manure. The alsike clover on other than the manure plats was originally in the soil, since it is known that the timothy seed sown was pure. The residual effect of the stable manure in increasing the yield of hay was quite marked, the apparent increase being 1.3 tons per acre where 10 tons of stable manure had been applied in the fall of 1903, and over 2 tons per acre where 20 tons of stable manure had been applied per acre. This increase in yield, however, was not due entirely to an increase in the yield of timothy. Although the manure when applied had been lying in a pile for two years and was well rotted, it subsequently developed that it contained considerable quantity of live red clover and alsike clover seeds. It is estimated that upon these plats clover made up three-fifths to two-thirds of the weight of the crop. It is evident, however, from the table on page 282 that the financial returns from the use of stable manure are eminently satisfactory, provided it does not cost more than 50 cents a ton to apply the manure. Neither upon the oats nor upon the

717	716	715
No treatment.	320 lbs. Acid Phosphate.	160 lbs. Nitrate Soda.
2200 lbs. hay per a.	160 lbs. Nitrate Soda.	3550 lbs. hay per a.
	3840 lbs. hay per a.	

FIG. 18.—*These plats show in a very marked way the influence of nitrate of soda on the yield of hay.*

timothy did the lime show any effect. It is true that in general the north end of each plat on which the lime was applied seemed to produce better hay than the south end. This, however, is believed to be due to the application of remnants of fertilizers (see page 277). Since there was no line of demarkation in the growing crop between the two ends of the plat, it was not deemed necessary to weigh the crop from the two ends separately.

SUMMARY.

1. Oats and timothy were sown on Dunkirk clay loam which the previous fall had been treated with commercial fertilizers, stable manure and lime. In the spring following the year in which the oats were harvested, commercial fertilizers were applied, but stable manure and lime were not again applied. The primary purpose was to study the influence of fertilizers upon meadows, the introduction of oats being merely to make the trial conform to farm practice.

720
No treatment.
2470 lbs. hay per a.

719
160 lbs. Nitrate Soda.
80 lbs. Muriate Potash.
4280 lbs. hay per a.

718
320 lbs. Acid Phosphate.
80 lbs. Muriate of Potash.
2800 lbs. per a.

FIG. 19.—*Increased yield is not the only factor in the economy of applying fertilizers. Plat 718 shows an increase in yield, but this does not balance the cost by fifty cents.*

2. The average yield of oats on eight plats not fertilized was at the rate of 53.8 bushels per acre; upon 14 fertilized plats, 59.6 bushels. The apparent increase in yield was most marked where a complete fertilizer high in nitrogen and phosphoric acid was used and where twenty tons of stable manure were applied per acre. The inference is that both nitrogen and phosphoric acid had an influence in increasing the yield of oats.

3. Upon timothy the influence of nitrogen was most marked as shown both in the growing crops and in the yield of hay. The results are striking and unmistakable. The average yield of hay

on eight plats receiving no fertilizer was at the rate of 2,160 pounds per acre; on three plats receiving only mineral fertilizers 2,890 pounds; on eight plats receiving nitrogen as nitrate of soda 4,676 pounds; and on two plats receiving nitrogen in stable manure 4,805 pounds.

An apparent increase in yield of 10.3 bushels of oats and 4,137 pounds of timothy hay was obtained from two applications of 320 pounds of nitrate of soda, 320 pounds of acid phosphate and 80 pounds of muriate of potash.

723	722	721
No treatment.	160 lbs. Nitrate Soda.	160 lbs. Nitrate Soda.
3200 lbs. hay per a.	80 lbs. Muriate Potash.	80 lbs. Muriate Potash.
	640 lbs. Acid Phosphate.	320 lbs. Acid Phosphate.
	4350 lbs. hay per a.	4590 lbs. hay per a.

FIG. 20.—*Both the yield produced as well as the cost of applying will be affected by the proportion of the ingredients of a fertilizer mixture. Observe the data for Plats* 721, 722, *and* 725 *on the influence of proportion of Nitrate of Soda and Acid Phosphate.*

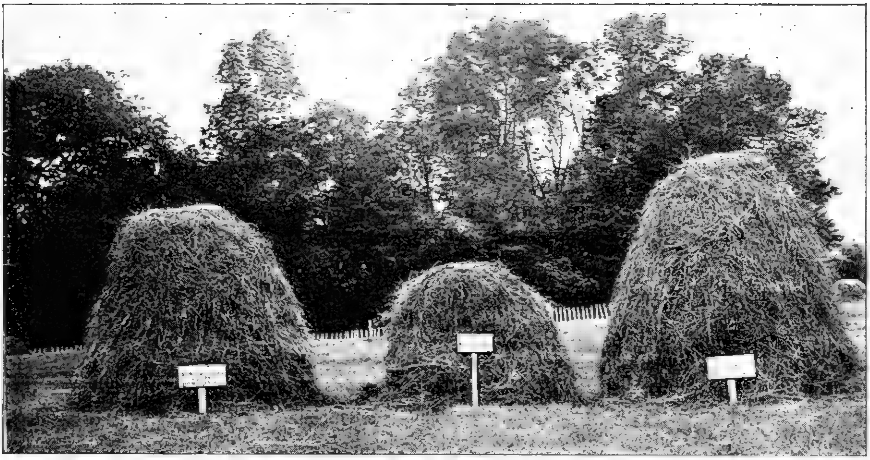
4. A single application of ten tons of stable manure produced an apparent increase of 5.3 bushels of oats and 2,595 pounds of hay; twenty tons produced an apparent increase of 11.2 bushels of oats and 4,025 pounds of hay per acre. Where stable manure was applied a material proportion of the hay consisted of red and alsike clover due to seed in the manure.

5. If stable manure can be applied at fifty cents per ton, the net gain from the use of ten tons was $10.55, and from twenty tons $15.14.

6. While a marked increase in hay was obtained from the use of fertilizers containing nitrogen, the small increase in the yield of oats left only a small net gain and in some instances a net loss from two applications. When the experiment is studied in detail it appears that the proportion of nitrogen to phosphoric acid should have been greater in order to get the most profitable returns.

When muriate of potash was applied either alone or with nitrate of soda there was a net gain.

7. It seems probable, moreover, that as the experiment continues the application of nitrate of soda or other readily soluble forms of



727	726	725
160 lbs. Nitrate Soda.	No treatment.	320 lbs. Nitrate Soda.
80 lbs. Muriate Potash.	2110 lbs. hay per a.	80 lbs. Muriate Potash.
320 lbs Acid Phosphate.		320 lbs. Acid Phosphate.
4310 lbs. hay per a.		6610 lbs. hay per a.

FIG. 21.—*Under conditions where fertilizers are effective, a complete fertilizer mixed in proper proportions will produce optimum results.*

nitrogen will become more profitable. The importance of this experiment, however, is in emphasizing the importance of systems of farm management which will bring to soils of this type in New York State the largest supply of readily available nitrogen. The use of leguminous crops and the proper preservation of stable manure and particularly the liquid excrement, which contains the larger part of the nitrogen excreted by domestic animals, is again emphasized.

8. No influence on the growth of timothy has been observed from the use of lime, but, in other experiments on the same soil type, marked results with lime have been obtained upon the growth of alfalfa.

PRESS BULLETIN NO. 5.

July 15, 1905.

BEAN ANTHRACNOSE, COMMONLY KNOWN AMONG GROWERS AS BLIGHT OR RUST.

The excessive rains of the past few weeks have brought about conditions very favorable to the development of many destructive fungus diseases of plants. One of the worst of these is the Bean Anthracnose. This disease is wrongly called by growers "Rust" or "Blight." The extraordinary abundance and destructiveness of the anthracnose throughout the bean growing districts of the State during recent years has disheartened many growers and threatens to discourage the extensive planting of this crop in the future. It is for the purpose of acquainting growers with the general nature of the disease and pointing out a remedy that this article is published.

HOW TO KNOW THE DISEASE.

The disease originates in almost every case from the planting of diseased seed. If conditions are favorable it may develop rapidly, killing the plants while yet quite young, or under other conditions it may not appear to any noticeable extent until the pods are well grown. These may become badly affected and the disease is then known as "pod spot."

Where it attacks the seedlings or young plants it is very readily recognized by the brown or black sunken spots or pits on the stems and cotyledons. In many cases the disease eats through the stem, causing the top to fall over from its own weight. When the very base of the stem is attacked the injury may appear to be due to some insect. Where the plants are affected after the leaves are well developed these too will show the disease, especially on the underside along the veins which become brownish and dead. The blade itself will often be covered with spots or cracks whose margins become brown and withered.

It is on the pods, however, that it becomes most characteristic and destructive, especially if the attack comes late in the season. Here it forms large dark brown sunken spots in the tissue. At the center of these pits a tiny pink mass may often be observed,—the spores or seed of the fungus. String or snap beans are often ruined, the disease often developing rapidly during shipment. Where the beans are left on the vines to ripen the disease gradually works through the pod and attacks the seed, forming pits or discolored places in the bean. Here, when the seeds are dried, the fungus remains dormant, only to become active again the next season when the diseased cotyledons are lifted above the soil on the growing stalks. Diseased seed may be detected by the discolored areas on the coat and are usually imperfect, shriveled or light in weight.

NATURE OF THE DISEASE.

The anthracnose of beans is not caused by weather conditions any more than a crop of corn is caused by the weather. If there are no seeds of corn in the soil the most favorable weather conditions cannot produce a crop. There will be no anthracnose if the fungus is not present in the soil or in the beans themselves when they are planted, or if it is not carried to healthy beans from diseased plants by insects or some other means. *Wet weather* does not cause Bean Anthracnose. It is caused by a minute parasitic plant which attaches itself to the growing bean, spreads through the tissue of stem, leaf or pod, destroying the tissue and using the substance for its own nourishment. The fungus consists entirely of tiny colorless threads in the tissue of the bean and the spores which are produced at the surface of the black spots. The spores are too small to be seen with the naked eye except where they occur in masses. These spores are held together by a gummy substance which is easily dissolved in water. After a heavy dew or rain these spores may easily become attached to insects which visit the diseased plants and so be carried to healthy ones. Hoeing the beans when they are wet is also sure to scatter the spores in flying drops of water.

RELATION OF THE WEATHER TO THE DISEASE.

While the weather is not directly responsible for the disease, it has very much to do with its prevalence and destructiveness. Good weather is very essential to a corn crop, but the grower may, by judicious cultivation, do much to make up for unfavorable weather conditions. So in the case of the anthracnose, by a proper understanding of the nature of the disease the bean grower may be able to so control it that he can grow a good crop even in seasons very favorable to its development.

When there is an abundance of moisture the spore masses quickly dissolve and the spores are easily distributed by insects, rabbits, or other animals running through the field, or by the hoe or cultivator. The spores will germinate only in moisture, so that in dry weather infections would not be abundant even if the spores were distributed. It ought to be clear, then, that wet weather is responsible for the disease only in that it affords the conditions most favorable for its spread and development.

REMEDIES.

The treatment for anthracnose must be preventative rather than curative. Below are given what are now considered the best means of controlling this trouble.

1. Plant clean seed. If possible obtain seed from fields known to be free from the anthracnose. If seed from diseased fields must be planted it should be carefully hand-sorted and all seeds not perfect and bright should be rejected.

While seed treatment has not generally been regarded as effective some experiments with formalin at this Station last year gave profitable results. The seed which was badly diseased was soaked for 45 minutes in formalin of the strength of 1 to 200.

2. Go over the field just after the beans are up and carefully remove and burn all diseased seedlings. If left on the ground they will simply serve as centers of infection for the growing plants.

3. Spray thoroughly with Bordeaux mixture. The normal strength should be used: 6 lbs. vitriol, 4 lbs. lime, 50–60 gal. water. The addition of resin soap will add to the effectiveness of the mixture by making it spread more evenly and it will be less easily washed off by rains. [Resin soap: 2 lbs. resin, 1 lb. crystallized sal soda, 2 quarts water. Boil until a clear brown solution is obtained.] Add this to 1 bbl. of the Bordeaux. Apply thoroughly with a nozzle giving a fine spray. The first application should be made just about the time the third leaf is expanding, or earlier if the disease appears to any considerable extent. Repeat the application three or four times at intervals of ten to fourteen days, or whenever the rains wash the Bordeaux off. Three applications will probably be enough for field beans. Weather conditions must largely determine the time and number of the applications. The writer has successfully treated string beans when they were nearly in blossom and where two-thirds of the plants were badly diseased. The plants most affected were removed, and the remainder sprayed twice with Bordeaux mixture.

Experiments in spraying for this disease are now under way at the Experiment Station here, and a bulletin on the disease is planned for next year.

4. Do not hoe or cultivate diseased beans when they are wet, as this would spread the disease to healthy plants.

While it is rather late in the season to begin spraying with hopes of complete success, growers whose fields are not too badly affected will find it quite profitable to remove badly diseased plants and spray thoroughly. We desire to correspond with growers who will be willing to undertake co-operative experiments in spraying for this disease next year. We shall be glad to examine and report on diseased beans which may be sent in. Be sure to send them well wrapped so that they will not dry out. Do not enclose in a letter. Where growers are not sure that they know the disease we will endeavor to send specimens if they are requested. Those who are interested in making further inquiries into the nature of this disease and its treatment will find the following bulletins of value. They may doubtless be obtained in most cases by addressing a request for the same to the director of the Station from which they are issued.

Bull. No. 48 New York Agr. Exp. Sta. 1892, Geneva, N. Y. (Probably now entirely out of print. This article will be found in the Eleventh (1892) Ann. Rept. of the Geneva State Exp. Sta., and also in the Transactions of the New York Agricultural Society for 1892).

Bull. No. 151 New Jersey Agr. Exp. Sta., 1901, New Brunswick, N. J.

Bull. No. 63 Delaware Agr. Exp. Sta., 1904, Newark, Del.

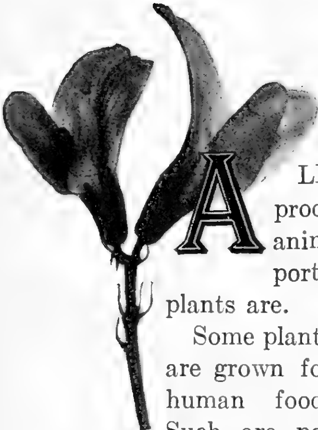
H. H. WHETZEL,
Plant Pathologist.

Cornell University Agricultural Experiment Station.

JUNIOR NATURALIST MONTHLIES.

And here, in Autumn's dusky reign,
A birth of blossoms seems again
To flush the woodland's fading train
With dreams of May.

—*John B. Tabb*



LESSON I.—THE ALFALFA PLANT

By L. H. Bailey.

ALL the things that the farmer sells are produced by plants and animals. The animals live on the plants. It is important that we know what some of these plants are.

Some plants are grown for human food. Such are potato, wheat, apple, lettuce. Some are grown only to feed to animals. Such are grasses and clover,—plants that are made into hay.

Hay is the most important crop in New York State. In fact, New York leads all the states in the value of the hay and forage. This value is more than 66 millions of dollars.

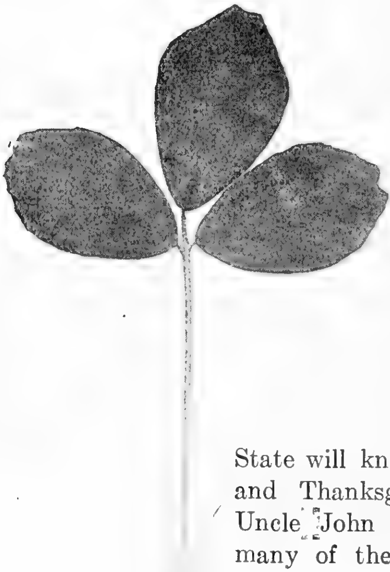
Hay is important in New York also because there are so many dairy cattle in the state. There are more than one and one-half millions of dairy cattle in New York. In the value of the milk and butter and cheese, New York also leads all other states. There are also great numbers of beef cattle, horses, mules and sheep. All these millions

2. *Sprig of the alfalfa plant.*

of animals must be supplied with hay in our long cold winters.

Hay is made in New York State from grasses and clover. Suppose we could find some plant that would yield twice as much hay as clover yields and be more than twice as nutritious,—you can readily see how valuable such a plant would be to the State. It would be better than a gift of millions of dollars. Such a plant is alfalfa.

Now that you know something about alfalfa in a general way, we want you to know how the plant looks and how it grows. It is not very well known even among farmers, but its cultivation is increasing every year. You will probably know where there are fields of it. Sometimes it grows along roadsides as a weed. Last spring Uncle John offered to send a small packet of alfalfa seeds to any Junior Naturalist who wrote for it. He sent about 5,000 packets. But if you do not know the plant or cannot find it, *write at once to Uncle John and he will send you some by mail from the University farm.*



3. *What leaf is this? Is it enlarged?*

Now let us see how many school children in New York State will know what alfalfa is between now and Thanksgiving time. When writing to Uncle John about alfalfa, try to answer as many of the following questions as possible from your own observation:

1. Does the plant remind you of any other plant that you ever saw? Of what?
2. How does it grow,—straight up or spreading out on the ground?
3. How many stalks come from one root?
4. What are the leaves like? Mark out the shape with a pencil.
5. What are the flowers like? Do you know any other flowers of similar shape? What is the color?
6. If possible, dig around a plant and describe how the root looks. Does it branch into many fibres, as grass roots or corn roots do?

UNCLE JOHN'S LETTER ABOUT THE ALFALFA GARDENS.

MY DEAR BOYS AND GIRLS:

Do you know much about the alfalfa plant? Do you remember that last spring we promised to send a packet of seed to each of you who asked for it? Did you send your name asking that you be served? We received the names of several thousand children asking for seed and I am wondering whether you are one of them. If so, did you sow the seed? Will you write me a letter telling me what became of it?

I am very fond of children's letters. Each year I receive more than thirty thousand of them. I sometimes wonder whether there is another man who is honored by so many letters from young people, for I count it an honor to be so remembered.

As large as that number is, I cannot spare one letter. I always want a few more. All your letters are read and I take great pains to answer all questions. If, by any oversight, you have been missed I am sorry. I know what it costs a boy or girl to write a letter. I never open one without feeling that the writer is a friend of mine, otherwise he would not have expended so much hard work to write it.

School has now begun and of course you are very busy, and so is your teacher. One of the best opportunities to write letters is in school. Please ask your teacher whether you may not write me during your language period. You may say that she may make authors of all of you if she can, but I will do all I can to help you become good letter writers. Ask her whether a letter to me may not be a substitute for a composition.

In your letter you may tell me your experience with alfalfa. Tell me your failures as well as your successes. Even though you received your seeds and did not sow them, tell me that. I shall never find fault with you for telling me the truth. If you sowed the seed and the plants did not do well, tell me that also. The plants may look very small and uninteresting to you this year, but next year they may surprise you.

In some parts of the United States the alfalfa crop is of great value and the loss of it would bring distress to many farmers. I am wondering whether the crop, as raised in all parts of our country, is not worth more money than all the gold found in the Klondike, taking the two year by year. I do not know how that may be. I am wondering. Men by the thousand have gone to the gold mines and endured many hardships and later returned with less money than those who had remained at home and took care of their alfalfa.

It may be that a mine of wealth lies very near you, and to get it you may have to ask alfalfa to find it and bring it to you. Gold cannot be found in all places in a gold country, and alfalfa may not feel comfortable and grow in all parts of a good farming country. What we asked of you last spring was that you become alfalfa prospectors and later tell us what you found.

JOHN W. SPENCER.

LESSON II.—GOOD BYE SUNFLOWER.

The wind-flower and the violet
They perished long ago,
And the briar-rose and the orchis died amid the summer glow;
But on the hill the golden-rod, and the aster in the wood,
And the yellow sunflower by the brook
In Autumn beauty stood. —*William Cullen Bryant.*

In seed-time I like to walk in my garden. There the sturdy plants that during the long summer have made the most of sunshine and rain, are ready to show me what they have done. I always look at each one carefully. I always wonder and wonder as I look.

Yesterday, along brown paths of tan bark, I walked among my old-fashioned plants. Many kinds, zinnias, asters and the like, were still blooming brightly. "Not yet, not yet!" they said as I passed. Seed-time for them was still to come.

But in one corner with "down-drooping face" stood my old friend, the sunflower. I lifted up the heavy head and saw—I shall not tell you what, lest you lose the pleasure of finding out for yourself. The seed-time of the sunflower is a wonderful thing. Some October day will you look closely at one and tell me what you see? Will you also look at the soil in which the plant grew? What color is it and how does it feel when you hold it in your hands? Every naturalist should notice the soil in which thrifty plants are growing.

And this is not all. We want you to take the sunflower head into the school room and ask other Junior Naturalists to help you count the seeds. How many do you find? Save every seed, for later in the year you will need them in making some interesting experiments. It will be well to ask the teacher to take care of the seeds until you are ready to use them.

LESSON III.—CHIPMUNK IN AUTUMN WOODS.

"What luck, John?" I asked my young friend as he jumped over the rail fence and joined me in the meadow.

"First rate," he answered, opening his bag and showing me the goodly supply of brown nuts that he had gathered. "I have more than the other fellow and he worked twice as hard as I did."

"Then you had company?"

4. *Chipmunk.*

"Yes. I met a little chap in the wood. He had very bright eyes, a rather small tail, and wore a fur coat with stripes along the back. It was great fun to watch him. Chipmunks are such busy little things."

You see John is a naturalist. This is why he had such a happy afternoon with his furry little friend out under the trees. He was very willing to tell me what he had learned about the ways of chipmunks. It then occurred to me that other young naturalists might like to make some observations on chipmunks this year. Will not these "nutty days" be a good time to begin? Here are some things to think about as you watch them:

1. Where do you more often see a chipmunk, on the ground or in the trees?

2. What are its colors above and below?

3. Look at the stripes on its back. How many are there? How far do they extend on the back?

4. In what way does the chipmunk's tail differ from that of the red squirrel?

5. How far from the ground on a tree have you seen a chipmunk? Does it ever jump from bough to bough?

6. How does it carry its food?

7. What different kinds of food have you seen a chipmunk eating? What seeds does it distribute? Do you think that a chipmunk has ever planted a tree?

8. Is it a useful tenant on a farm? Give a reason for your answer.

9. It is said that chipmunks are easily tamed. We should like to know what success Junior Naturalists have had in gaining their confidence.

LESSON IV.—SOMETHING ABOUT SOIL.

Last spring when we asked the members of the Junior Naturalist Club to prepare for us some work on soils we did not feel at all sure that they would be willing to do it. Uncle John was very much pleased, however, to find that a large number of children wrote excellent letters on this subject. When reading some of the letters we could not tell whether the children had actually done the work themselves or whether they had learned their facts from others. In all the experiments, let us know just what part you took in them. The following letter pleased us very much:

Dear Uncle John:—

I will write and tell you all I know about soils. I experimented to-day by putting some dirt into a tin and put the tin on some coals for a while. When I took it off and looked at it carefully, I found the dirt that was burned was much softer than the other soil and that the lumps had all gone out and it looked like ashes. We named five soils. We think the mucky soil is the best for flowers. To-day some of us went into the woods to get some mucky soil. Your nephew,

JESSE.

The above letter tells us that Jesse gathered soil, that he looked at it carefully, and that he experimented, as we asked him to do.

Here is another good letter:

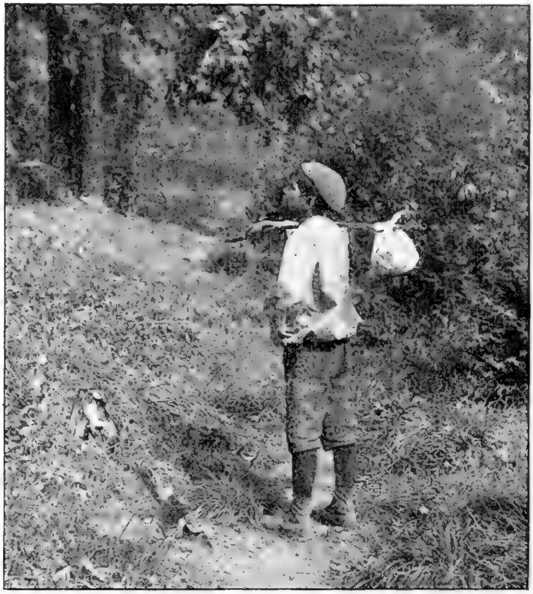
Dear Uncle John:—

I have looked for and found a good many kinds of soils. The wet and dry, stony, gravelly, coarse grained and fine grained soils. Some of the soils were different colored. The black soil is rich and that is what we have in our garden and flower beds. We took a pail of sandy and clayey soil and studied it. Then in some soil we found sticks, roots and other decayed plants. This is what makes the soil rich.

When we went into the woods Arbor Day to get flowers and plants we found the rich soil by the creek. Your niece,

EVA.

We learn from Eva's letter that after she had studied soils in the school room, she observed them out of doors.



5. *The chipmunk boy.*

This year we hope to give several lessons on soils and we want you to get some material for them during the fall days. It would be a good idea to take a field trip for the purpose of collecting soils. Get some from the garden, some from open fields, and some from the woods. Try to find as many different kinds as possible. It will be well to have four or five paper bags or glass fruit-cans with you so that you can take several samples back to your school room. On each bag or can paste a piece of white paper on which write where you found the soil. Put the soils into the school room cupboard until we ask you to make some experiments. Be sure to write and tell us whether you have collected the samples.

LESSON V.—HOW CAN WE PROTECT THE WILD FLOWERS?

Have you ever thought how much we should miss the spring flowers if they no longer appeared in the wood and along the wayside? What if the trailing arbutus and the hepatica should never come to us again?

What if we searched in vain for Jack-in-the-pulpit, Dutchman's breeches, painted trillium, yellow violets, or sweet briar roses?

Yet, unless something is done to protect the wild flowers, I fear that one by one they may leave us, or at least become scarce in their accustomed places. Thoughtless persons gather all they can find and carelessly uproot many. We always suggest to Junior Naturalists lessons on common and abundant plants, both because they should mean more to you and because there is no danger that they will be entirely destroyed.

We want Junior Naturalists to think on this question and write us about it. Next February, we shall publish two letters, one written by a girl the other by a boy, giving the best suggestions for protecting the wild flowers. Uncle John hopes that a good many young people will help him in this matter.

LESSON VI.—CANADA THISTLES AND OTHER SEEDS.

We hear many farmers complain of the Canada thistle. Can you tell why? If you study it this fall you may learn new things about it. Perhaps some good-sized boy will be brave enough to get a large thistle plant for one of the Club meetings. He will need to be something of a Spartan, but I believe many of our boys will have the courage to do it. I would suggest in your study of the plant that you consider the following:

1. The kind of root.
2. The number of blossoms.
3. The number of seeds in a blossom-head.
4. Multiply the number of seeds in one of the blossom-heads of any kind of thistle by the number of heads on the plant. If one-tenth of the seeds of such a plant should produce plants next year, do you think the farmer living near it would be pleased?
5. How many good and plump seeds do you find in each head of Canada thistle? Be very careful about this observation.
6. How are the seeds of thistles fitted for traveling?
7. Does the Canada thistle have any other way of traveling except by seeds? Be careful in answering this.
8. Can you suggest any way by which we can get rid of the Canada thistle?

NOTE:—Uncle John would like to know the name of the boy who brings the thistle plant to school.

THE LETTERS TO UNCLE JOHN.

A few remarks on the kind of letters that are most pleasing to Uncle John may be helpful to the members of the club. Following are the most important points:

1. Always give your address and be sure to sign your full name.
2. Do not feel that you must write on all the topics suggested in the Leaflet. Select those that interest you most.
3. In your letters tell us the things that you have found out for yourself, not the things that you have read or that others have told you. Uncle John would rather have you tell him two or three simple things that you have learned from your own out-door study than to have you write pages of facts that you have heard or read. A very satisfactory letter reads as follows:

My dear Uncle John:—

A few days ago I found three trees which have been bored by the sapsucker. On one tree the holes went all around the trunk and half way up the branches, but on the two others the holes were scattered about. The trees I saw were bored last spring by the sapsucker. As there was no sap near the holes, I think he eats the inner bark of the trees, as the holes are quite deep. I have never seen insects near the holes, so I do not know if the sapsucker eats them. I have been looking for a sapsucker almost every day since the Junior Naturalist paper came.

The Hepatica.—Hepaticas grow in very shady and damp places. I think they get most of the sunlight during the spring before the leaves come out. I did not see the first sign of life, so I cannot tell you about it. The flowers come first, and the leaves do not come until quite awhile after the flowers. The hepatica has three different parts. The three small leaves are a part of the stem, as they are quite a little distance from the flower. The stem is very long and hairy. The new leaves of the hepatica that I saw, looked very fuzzy on the outside and not at all so on the inside. I did not watch the leaves unfold, as I did not have a hepatica in a pot. I have found the hepatica in three different colors,—blue, pink and lilac. I think some smell sweeter than others, and I also think the color has a great deal to do with it. On a sunshiny day the hepatica is wide open, and on a stormy day it is closed up tight. I think the hepatica has from ten to twenty-five seeds.

Your niece,
SALLIE.

Junior Naturalists ask many questions. We are glad of this. We intend to answer every question. Last school year Uncle John received from Junior Naturalists 33,171 letters.

O,—fruit loved of boyhood! The old days recalling,
When wood-grapes were purpling and brown nuts were falling!
When wild, ugly faces we carved on its skin,
Glaring out through the dark with a candle within!
When we laughed round the corn-heap with hearts all in tune,
Our chair a broad pumpkin,—our lantern the moon,
Telling tales of the fairy who traveled like steam,
In a pumpkin-shell coach with two rats for her team.

—*John Greenleaf Whittier.*

LESSON I.—THE PUMPKIN.

L. H. BAILEY.

In October the cornfields were golden with pumpkins. The corn was in shocks. The tassels were ripe and dry, and hung downward as if mourning for the dying year. The maple leaves, yellow and red, were falling to the ground like flocks of brilliant birds. Lonely hickory trees held on to their dun-yellow leaves as if loth to let them go. But the pumpkins seemed to be in their prime. Fat and sleek they lay between the corn shocks, and shone out among the drying weeds. We did not remember to have seen them before.

It is now November. Heavy frosts have come. One night the brook was frozen nearly to its middle. Much of the corn is still in the shock, but the pumpkins have been taken under cover. They lie in heaps on the barn floor. The hay and straw falls over them. Still the old cow can smell them. I like to sit on them, and run my fingers down their smooth, broad grooves.

In some parts of the State, I miss the pumpkins in the cornfields. These are the regions in which there are many silos; corn is grown in large fields; corn harvesters are used. The absence of the pumpkin tells me of a change in the kind of farming since I was a child. Now you want to ask me some questions; but I shall ask them first of you. Some one in school or in your neighborhood can answer them for you, if you do not know.

My first questions are these:

1. What is a silo and what is it used for?
2. What do the farmers who have silos raise to sell?
3. Why are pumpkins so often planted amongst corn?
4. Do you know of any other kinds of plants that grow underneath taller plants (look under the trees, even in the dooryard; and in the orchard; and under the currant bushes)?

But you must tell me something about the pumpkin itself. You have made jack-lanterns, and you will know. You know the Hubbard squash; but why did you never make a jack-lantern from one? Look at the pumpkin and the Hubbard squash again. If you live in town, you can stop at the grocer's and see them. But I suggest that you children take some pumpkins and squashes to the schoolhouse,—all the kinds you can find. Put them on the platform or on the table. If they are nicely arranged, I am sure you will think them handsome. Then write Uncle John.

5. How many different kinds (or shapes) of pumpkins do you know?

6. What kind of stem does the pumpkin have? How does it differ in this respect from the Hubbard squash?

7. Look at the blossom end of both; how do they differ?

8. Look at their shape and tell how they differ.

9. Can you see any difference in the seeds of the pumpkin and the Hubbard squash?

10. Explain any difference in color.

If you cannot secure a Hubbard squash, then make the observations on the pumpkin alone.

LESSON II.—STAGHORN SUMACS IN NOVEMBER.

RALPH W. CURTIS.

The woods are not dead because the leaves have fallen. The trees now stand out bold and free with masks thrown aside, as it were, and faces bare. Look at that sturdy oak! And yonder elm, how graceful its outlines! See how the lombardy poplar points heavenward like a church spire in the landscape. Notice the ivory branches of the sycamore, the beautiful gray of the beech trunks, the outstretched limbs of the chestnut, the gnarled and twisted branches of the little hawthorn.

And there are the sumacs. Now that the leaves are gone and woods and fields take on the soft grays and browns of winter, how the great crimson heads of the sumac stand out big and clear, easy to see from far away. 1. Let us see what we can learn from these common shrubs.

A FEW SUGGESTIONS.

1. Look at the colony of sumacs for a few minutes. Write in your note-books answers to the following:

Where is the colony growing? In the open field? In the fence corner? On the edge of the wood?

How many colors can you find as you look at one shrub closely?

2. Break a live winter twig of sumac. A milky sap oozes out. Is this sap sticky like resin? Wet or dry, sumac branches make the best of camp-fires. Why?

3. Look carefully at the same twig. See how very hairy it is. Notice the silky buds and the narrow, circular leaf-scar that nearly surrounds each. Some day you will find that the sumac hides its leaves beneath the base of the leaf stem.

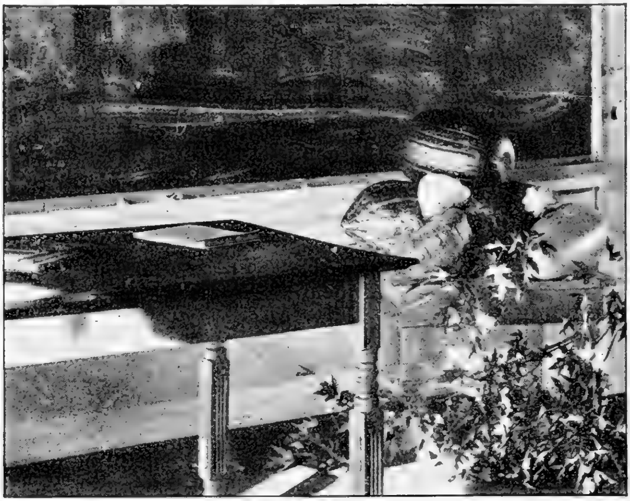


FIG. 1.—*Pumpkins and squashes in the school-room.*

OTHER SUMACS.

Nearly all boys and girls know the staghorn sumac, but I doubt whether you are familiar with some of its near relations. One or two of these are poisonous. You ought to know the poisonous forms that you may avoid them. Here is a brief description of the different kinds in winter.

The staghorn sumac is a large shrub with velvety-hairy branches. The fruit or seed part is terminal, *i. e.*, on the end of the branches, and is composed of a dense cluster of red, hairy berries. Fig. 3 and 4 (1).

Smooth sumac is often a large shrub but the branches are smooth. The fruit is terminal like that of the staghorn sumac but does not make such a stiff, dense cluster. Fig. 4 (4).

Poison sumac or "poison elder" is also a large shrub but grows only in swamps or moist places. The twigs are mottled brown and gray. The fruits are round, waxy berries (dry and hard in winter) borne in loose, slender clusters which, instead of being terminal, are axillary, *i. e.*, growing out of the sides of the branches in the axils of the leaves. If the leaves have fallen the leaf-scars are still there and are big and broad, not narrow and circular like those of the staghorn sumac. Fig. 4 (5).

Fragrant sumac, a low shrub. The fruit is in small clusters of red, hairy berries which fall off early in winter. The small clusters on the present twigs are next year's flowers which open very early in the spring before the leaves. The wood is sweet scented. Fig. 4 (2).

Poison ivy or poison oak (a true sumac and by far the most common poisonous plant in the United States) a low shrub or climbing vine, with light brown twigs. The fruit is like that of the poison sumac and the leaf-scars, in proportion to the twig, are also similar. Fig. 4 (3).

LESSON III.—SOILS.

Gather dried but not decayed leaves of the staghorn sumac, oak, hickory or maple. Using your hands, grind up the leaves. Moisten them. Get a saucer full of yellow or gray soil. Moisten it quite wet. Place the moist leaves in the soil and mix them in well. Set the saucer in a warm place and stir the dirt and leaves occasionally. What happens? What becomes of the leaves in the forest? What becomes of tree stumps? What happens to the grass that is plowed under? What happens to dead bugs? Who ever saw a dead English sparrow? What becomes of the bodies of dead birds? What do angle worms do with the dead leaves? If you do not know, put an angle worm in a flower jar of moist soil with a lantern globe over it. Place a few dead leaves on top of the soil and watch what happens. Why should the above questions be of interest to young gardeners and naturalists?

LESSON IV.—NOTE-BOOKS.

As soon as members of the club receive their November Leaflets we want you to get a small note-book in which you can keep a record of all that interests you in the out-door world. Every senior naturalist does this. Later in the year we shall ask you to copy a page from your note-book and send it to us, that we may have it published in the *Junior Naturalist Monthly*. You may watch a tree or bird or some other out-door thing for several days or weeks and write in your note-book all that you can learn from your observations. Such records will be very interesting to Uncle John.

LESSON V.—A COLLECTION OF SEEDS.

"I like the plants which you call weeds,—
Sedge, hardhack, mullein, yarrow,—
That knit their roots and sift their seeds
Where any grassy wheel-track leads
Through country by-ways narrow." —*Lucy Larcom.*

Brown fields, brown weeds, brown tree trunks; let us look at them all. Let us study the old brown weeds.

Girls and boys like to make collections of things. How many different kinds of seeds can you find these November days? Suppose all the members of the club spend one week collecting seeds and let us know at the end of that time how many different kinds you have found? Which weed in seed-time interests you most? Why?

LESSON VI.—HOW TO GROW PAPER WHITE NARCISSUS.

JOHN W. SPENCER.

Materials: A glass dish that will hold about a quart. Some clean sand and pebbles. Six bulbs of Paper White Narcissus that can be bought for a few cents.

When the materials are all ready this is what Uncle John wants you to do: Put the sand in the bottom of your glass dish, then set your bulbs up on end; not too close, about an inch apart will be the best. The bulbs stand up as straight as six little majors. Place the pebbles in between the bulbs and on the outside of them. The pebbles are props which keep the little majors standing as straight as you have placed them. Pour some water into the dish so that the bulbs are three-quarters covered. Put the water in carefully that you may not wash the sand and pebbles out of place. Set the dish in the window and the Narcissus plants will be ready to grow. All you will need to do is to occasionally add water. Each week I wish you would write us the changes you see, even the smallest changes. When your plants have blossomed send your old Uncle John your notes.

NOTE:—Please send Uncle John the name of the boy who makes the largest collection of seeds.

LESSON VII.—A LITTLE FARM TENANT.

The leaves have fallen and the orchard is still; but we like to be out among the old apple trees, the downy woodpecker and I. He works and I watch him, this useful little farm hand.

You must not confound the downy woodpecker with his near relation, the sapsucker, that drills rings of holes in the orchard trees. The sapsucker has yellow on the under parts instead of white and, if you look closely, you will find other ways in which he differs from the downy.

When you go into the orchard and see a woodpecker on one of the trees, look at him very closely. Is he smaller than a robin, black above, white below, and red on the nape? If so, he is a downy woodpecker. The female bird has no red on the nape.

In a former Leaflet we have told you why the downy woodpecker is a valuable tenant on the farm. This year we want you to tell us from your own observations why he is helpful. Here are some things to think about as you study him:

1. What does the downy woodpecker find to eat under the bark of trees? Have you ever looked to see?

2. Notice his toes. How are they arranged?

3. How does he brace himself as he works? Watch him do this.

4. Have you ever seen him eat seeds of weeds that farmers do not like on their lands?

5. Fasten a piece of suet to a tree near your home, and I doubt not that the downy woodpecker will often visit you.

LETTERS TO UNCLE JOHN.

As the days go by and we receive letters from our boys and girls, we find them more and more satisfactory. A few years ago Junior Naturalists often wrote us about things that they read in books. Now they are telling us of the things they themselves see. Each month we hope to publish two or three of the best letters. Here is one that is excellent:

Dear Uncle John:—

This morning I got a basket full of dandelions with flowers on for the teacher and we are studying them now. On the dandelion which has a yellow flower, are two colors, yellow and green. The dandelion with the balloon has two colors, white and green. When the boys play ball and play a little late, some take the dandelion balloon and blow it three times. If all the seeds go off, their mother wants them.

We had no school Thursday afternoon and so I went out to Capron on a wagon with my uncle. I saw one field just full of the stems of the balloons, because all

FIG. 4.—*Fruit and twigs of the common sumacs or shoe-macks. 1, Staghorn; 2, fragrant sumac; 3, poison ivy; 4, smooth sumac; 5, poison sumac.*

the balloons were carried off by the wind. Then the wind was blowing west and there was a clump of bushes and behind these bushes it was just white, for the wind could not get at them and blow the dandelions away. I think next year that all the fields around this field will be covered with dandelions because the wind must have planted some seed there.

The sky was overcast with clouds when I gathered the basket of dandelions.

The dandelion I am studying has seven buds not open yet and on top they feel like silk.

Your nephew,

——— ———

We are sorry that we have not the name of the writer of the above. The letter pleases us because the young naturalist not only gathered and studied the dandelions, but he also noticed other out-door things, —the direction of the wind, the overcast sky, and where the dandelion seeds fell.

LESSON I.—HORSES.

A few minutes ago I went out into the stable to see Peg and Nan, the two bay horses. On the outside of each stall I found a door-plate with *Nan* written in large, black letters on one, *Peg* on the other. I visited each old friend in turn.

They are quite different in disposition, these two horses. Nan is gentle, affectionate, patient; Peg is spirited, unfriendly, restless. I am very fond of them both and as yet have not been able to decide which I enjoy the more, quiet Nan or spirited Peg.

All horses are interesting to me. As I take my daily walk, I like to look at the different ones I meet along the way. There is the baker's horse and the butcher's; the doctor's horse, sleek and active; the heavy gray horses that carry loads of coal up the hill all through the winter weather; "Old Speckle," the postman's horse; and the friendly bay I so often see feeding in the meadow.

Of all these wayside acquaintances, I like the one I meet in the meadow best. Perhaps I associate him with the meadow-lark's song, the fresh, green grass, and the gay little dandelions that were about when I first crossed his path; or perhaps our friendship progressed more rapidly than city streets ever will permit. He seems to know when I am approaching and raises his head in welcome. I always pet him and talk to him a bit, and we both know that two friends have met.

Sometimes when I reach home I think of the different horses that I have seen during the day and wonder about them. Where is "Old Speckle" in the evening and through the long nights? Day in and day out I meet him in almost the same place along the highway and watch his ready response to his master's command. In addition to food and lodging, does he, I wonder, receive an occasional friendly word or an encouraging pat on the head? I hope he does, and I hope, too, that all the others are tenderly cared for.

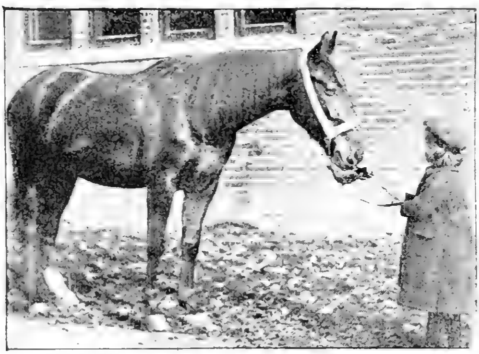


Fig. 1.—*Nan.*

There are many things about horses that everyone ought to know. If we were to ask Junior Naturalists how coach horses differ from roadsters and how roadsters differ from draft horses, how many would be able to tell us? And if several horses, the doctor's, the baker's, the coal dealer's, the grocer's and others stood in a row, would you know whether there was a true draft horse or roadster or coach horse among them?

Perhaps you will ask, "What is a draft horse?" The draft horse has short legs, a heavy body, a short, thick neck, broad, deep chest and shoulders, strong hocks, and moderately large feet. It may be

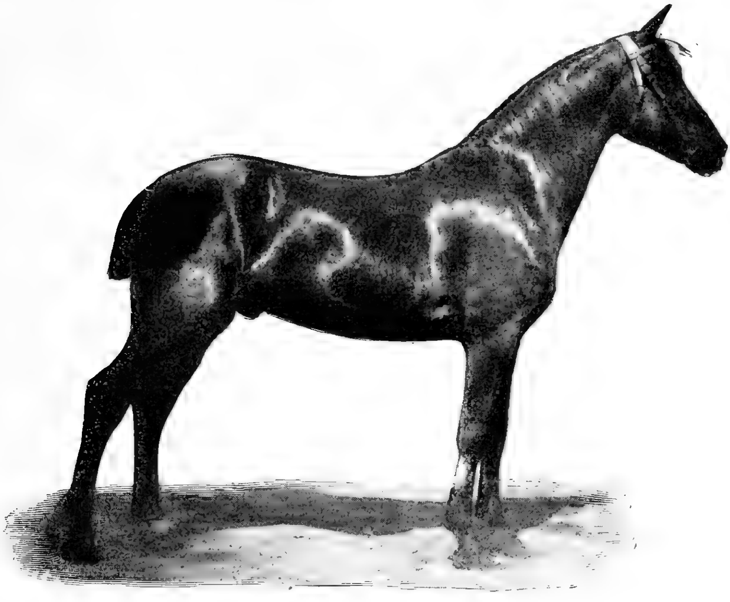


FIG. 2.—*A good coacher.*

that your father owns a draft horse. Ask him whether it is a Percheron, a Clydesdale, or an English Shire. These are the most familiar breeds of draft horses. The Percherons came from France and at first they were gray. Now they are often black or dark brown. The Shires, commonly bay, brown, or sorrel, came from England; and the Clydesdale, similar in appearance to the Shires but smaller and more active, came from Scotland.

All boys and girls know coach horses. As you stand by the schoolroom window, you may see one pass. They have long, arched necks and fine heads. Their bodies are round and well proportioned.

Roadsters, trotters, and saddle horses are usually not so large as coachers. Their necks are inclined to be longer and their chests narrower than the coach horse; however, their muscles and tendons are strong.

Now, you must not think that just because a horse is drawing a load, he is a draft horse; nor because a horse is hitched to a coach, he is a coach horse; nor because he is driven on the road that he is a roadster. These three names,—draft horses, coach horses, roadsters, —represent types or classes. They mean kinds of horses that are supposed to be best adapted for drawing, or for coaches and carriages, or for fast driving, if the horse has no other work to do. But the horses that you usually see are just mere common horses, of no particular type, and are used for a great variety of purposes. You would not think of putting a true draft horse, like the animal in Fig. 3, on a light carriage; nor of hitching a coach horse like that in Fig. 8 to a coal wagon. Do you think there is any real roadster, or coach horse, or draft horse in your neighborhood? If not, perhaps you can tell, as the horses pass you, whether they are nearest like one type or another. Try it.

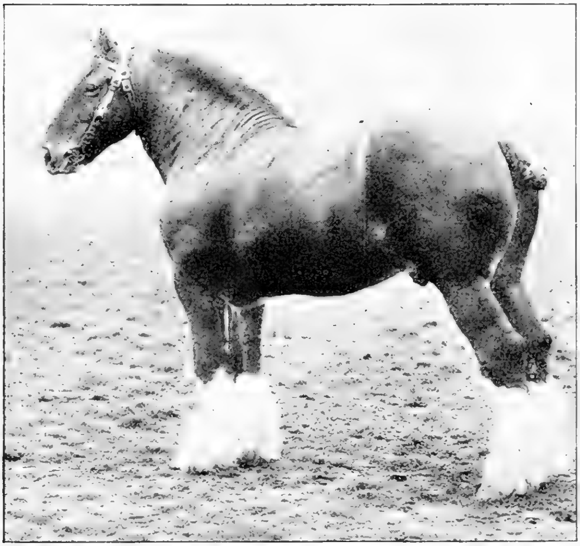


FIG. 3.—*A typical draft horse.*

SOME IMPORTANT FACTS IN THE STUDY OF HORSES.

I. P. ROBERTS.

If you will observe horses closely, you will find that some are large, heavy, and strong and that they are seldom made to move rapidly; while others may be nearly as tall, but they are slim and carry their heads high and their necks arched. You should also notice that the heavy draft horse does not lift his feet high or walk with a proud and lofty tread; while the coach horse lifts his feet high, carries his head high, and moves very proudly.

There are several breeds of draft or heavy horses. Fig. 3 shows a fine Clydesdale horse imported from Scotland. Notice how nicely he is marked. The horseman would say that he has four "white stockings" and plenty of "feather" on his fetlock; strange, is it not, that this long hair should be called "feather?"

If you should see a large, smooth, gray horse similar to the Clyde without the "white stockings" or the "feather," you may conclude that he is a Percheron horse. As we have said before, the Percheron breed of horses came from France. It is not always gray in color. It is slightly smaller than the Clydesdale.

After you have learned that a draft horse should be large and strong, study the picture of the coach horse, Fig. 2. Compare him with the draft horse. The coach horse is not a fast trotter nor even a fast roadster, but he is usually very beautiful, strong and stylish.

Now I shall ask you to compare the neck shown in Fig. 4 with that shown in Fig. 5. Which do you think is the more beautiful? The horse with the long, slim neck is a noted trotter. If the neck and head were large, would it help or hinder the trotter? Compare the neck of the trotter with that of the draft horse and see whether you can explain why one is heavy and the other light. Can you explain to your parents why the draft horse should weigh more than the coach horse?

Do you admire the head and neck shown in Fig. 5? Wherein does it differ from the others? This type is called "ewe-neck": Can you tell why? Tell me whether you think this horse would be a safe driver.

What do you think of the head and neck of the Arabian horse, Fig. 6? You like it, do you? Why? Can you imagine what kind of horse belongs to that head and neck? Describe it.

Probably the Arabian horse would be too spirited for you, so I shall show you a Shetland pony, Fig. 7. Where is Shetland? Why are horses so small in the country where this little fellow came from? How does he differ from the other horses shown in this Leaflet? Note *all* of the differences.

In Fig. 8 you will see a Welsh pony and she has a poneyette, a baby only a few days old. Which is the larger, the Shetland pony or the Welsh pony? Which one would you prefer if the baby were left out? Could you raise a calf until it became a grown cow and then trade it for a pony? Just a plain little pony can be bought for

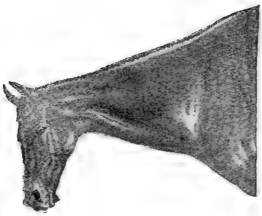


FIG 4.—*Neck of a trotter.*

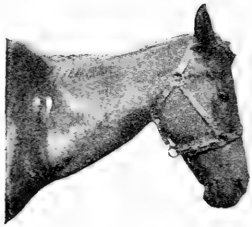


FIG. 5.—*Ewe-neck, a poor horse.*

the price of a good cow. It is part of a good education to know how to raise and handle cows and horses.

With this Leaflet in your hand, you should go to the stable, or, better still, go out on the street, and see whether you can find as good horses and ponies as the pictures represent. With the exception of Fig. 6, these pictures were made from photographs of living animals.

FIG. 6.—*Arabian horse.*

Most all of the horses that you will see are called by a long name — *nondescripts;* that means, horses which have a little draft blood, a little trotting blood, and a little unknown blood, as already described. Some of these may have draft bodies and coach-horse heads, or they may have trotting bodies and such necks as are shown in Fig. 4.

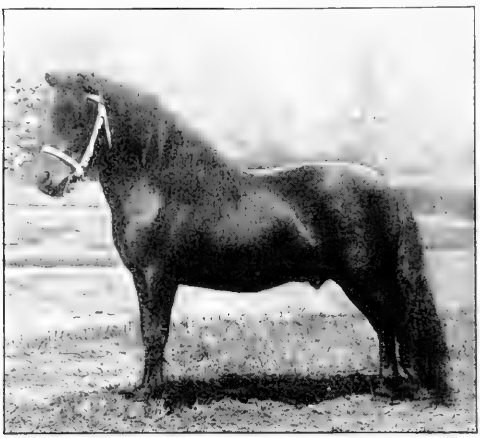


FIG. 7.—*Shetland pony.*

With the Leaflet as a guide and a living horse for comparison, you will learn a great deal about horses.

Can a horse sleep when standing?

How are the legs placed when a horse lies down?

How does a horse get up,—front legs first or hind legs first? How does a cow get up?

Where is the horse's knee joint? Which way does the knee bend?

Where is the hock joint? Which way does it bend?

When a horse starts, after standing, what foot does he first put forward,—the left or the right? The fore or the back foot? What foot moves next?

When a horse trots, do the two feet on one side move together? Or do lefts and rights move together?

What does the driver mean when he says that a horse "forges" or "overreaches?"

Name the things that a horse commonly eats What is a good feed for a day,—how much of each thing and when given?

FIG. 8.—*Welsh pony and its mother.*

LESSON II.—AMONG THE EVERGREENS.

RALPH CURTIS.

Away you go over drifted fields and on into the snow-covered wood. How clear and crisp the air! The wind murmurs among the pines; a flock of crows caw overhead; clear and sweet the chickadee pipes its note of welcome. It is not lonely in the winter wood.

There you will find evergreens, possibly many kinds. Look at these trees so that you can tell how they differ one from another in general appearance. Notice whether the trees are tall, whether the branches are spreading, whether the leaves are long or short, and whether the cones are large or small. After you have looked at the trees a little while, carefully take a branch from each of the different kinds. These you can study in the school-room where it is nice and warm, and find out some things that you cannot learn by looking at the trees. In Fig. 9 you will see are illustrations of four different kinds of evergreen boughs: the white pine; the pitch pine; the Norway spruce; the hemlock. Let us look at them carefully and compare them with the boughs we have brought in from the woods.

THE WHITE PINE.

1. What is the color of the bark on your white pine branch?
2. How long are the leaves?
3. Notice whether there is a little sheath at the base of each bundle that binds it together.
4. How many buds do you find on the branch?
5. Where are they situated?
6. Notice the cones; are they long or short?
7. On what part of the branch do you find them?
8. Are the scales of the cones opened or closed?
9. Do you find scales inside the cones? If so, describe them.

THE PITCH PINE.

1. Compare the bark on your branch of pitch pine with that on the white pine. How does it differ?
2. Notice how rigid are the leaves of the pitch pine and how straight they stand out from the branches.
3. Notice whether there is a sheath which binds the leaves together at the base.
4. How do the cones of the pitch pine compare in size with those of the white pine?
5. It takes the pitch pine three years to ripen its seeds. You will find in Fig. 7 near the end of the branch very tiny cones that have grown since spring. Farther along on the branch are the cones that are two years old. Notice how tightly closed they are. Then near the base of the branch there is a cone three years old. It has opened and scattered its seeds.

THE NORWAY SPRUCE.

1. In the spruce you will notice that the leaves are not arranged in clusters.
2. Find out whether there is a sheath at the base of the leaves.
3. Take out a leaf and tell us whether you find any stem on it.
4. Are the leaves stiff or soft and feathery?
5. As I look at a branch of Norway spruce, it seems as if the leaves were all on the upper side of the branch; is this so?

THE HEMLOCK.

1. Notice how pretty the hemlock trees are in this December weather. How one enjoys looking at a single branch such as we see in the illustration, Fig. 9.

2. Look at the branch of hemlock you have brought to school. Tell us ten different things about it:—the arrangement of the leaves, the length of the leaves, size of the cones, and other facts that you learn from your own observation.

LESSON III.—A CHRISTMAS TREE FOR THE BIRDS.

Do not forget to give the birds a Christmas tree this year. You will enjoy it as much as they. Let me tell you how to do it.

First, select the tree. An evergreen tree in your own garden will be best. Then I want you to think about the gifts for your little winter neighbors.

You know the chickadee, the little gray bird that wears a white waistcoat and a black cap? He is the one that says "Chick-a-dee-dee-dee-dee" or sings "Phoe-be" through the cold winter weather. Chickadee likes suet and I hope you will put a large piece on the tree for him. Doubtless other birds will share his gift. Tell us how many you see eating the suet. If you do not know the names of the birds, describe them.

A good-sized bone that has not been salted will attract crows, nuthatches and woodpeckers. Perhaps the downy woodpecker will come for his Christmas dinner. How glad you will be to see this sociable little bird!

Some of our winter neighbors are seed eaters:—tree sparrows, snow buntings and the like. You know what strong little bills they have. These bills were made to crack seeds. The sparrows and snow buntings will be pleased with a nice basket of seeds, so I should advise you to provide this gift for them. I want you to find out whether they take any of the gifts provided for the other birds. Do they eat the suet? Notice whether the English sparrow takes an interest in the tree.

DOGS.

As I walk through winter woods I often think of the time when white men did not live here; when forests were dense and wild; and when wolves ran howling on their way through the long, cold nights. But that was long ago. Probably not many of our boys and girls have ever heard or seen a wolf, unless he was a captive. Where have they gone, these wild dog-like animals, and why have they gone?

Foxes, near relatives of wolves, are not so rare. Have you ever seen one traveling along his solitary way? I say solitary way, because, as you know, foxes do not hunt in packs as do the wolves.

FIG. 1.—*Red fox.*

If you live on a farm, perhaps you can tell of a visit a fox has made to your home and whether or no you enjoyed having him there.

We may not be able to see wolves and foxes, but almost everywhere and every day we can see their tame relations,—dogs. I like the large dogs best:—St. Bernards, mastiffs, great Danes, collies and the like; yet some very small dogs have taken a large place in my life.

Now, every one of our boys and girls can tell a dog story and Uncle John will be glad to hear it; but there is something more we want you to do. Since dogs take so important a part in our daily life, we should know more about them. When you write to Uncle John again I hope you can tell at least one new thing that you have learned from your study of dogs this month.

On page 323 you will see illustrations of several dogs. These represent certain types and it will be interesting for you to compare the dogs you know with those in the pictures. Which one looks most like a wolf? Do any look like the fox? Note some strong points of difference between the fox and the wolf, between the fox and the dogs.

I think that one of the first things you should do is to name the *kinds* of dogs that you know. Last month you learned that horses

FIG. 2.—*Gray wolf.*

may belong to certain groups or classes (do you know what they are?); this month, let us learn the same for dogs. How many kinds of dogs do you know? Can you tell a bulldog when you see it? A spaniel? pointer? collie? bloodhound? St. Bernard? poodle? greyhound? mastiff? pug? foxterrier? Do you suppose all the dogs you see represent some named breed? Or are some of them just "common dogs," as most of the horses are "common horses" and not coachers or roadsters or draft horses? Write Uncle John, for your dues, a letter describing some kind of a dog. Can you describe it so that he could tell that kind of dog when he saw it, even though he had never seen this breed before?

If you could own one of the dogs illustrated on page 323, which would you choose? Do you like the bloodhound with its wise, almost human face? the mastiff? the greyhound that runs so fast and sees so far? the collie with its beautiful head and thick, rough coat? the queer little poodle, so quick to learn all sorts of tricks? the fierce bulldog? As you think about these dogs, compare them with those that you have known. Notice whether your dog is like any one of them. If he is different, which one, if any, does he most resemble?

OTHER SUGGESTIONS FOR STUDY.

1. Give your dog a bone and notice how he holds it.
2. How does a dog drink?
3. Does he sleep much in the daytime? What position does he most often take when he lies down? Does he always choose the same place in which to rest? Can you give a reason for his choice?
4. Have you ever tried to make a nice bed for your dog and has he always arranged it afterward to suit himself? Do you know whether wolves make beds for themselves in the forest?
5. You should keep fresh straw for your dog's bed and have his kennel white-washed inside once in a while; why?
6. Watch your dog hide a bone. How does he do it?
7. Which dog do you think is best to have in the farm home? Give a reason for your answer.
8. If you live on a farm, you may know what a shepherd dog is. What breed is the shepherd dog? Do you see any dog like him in the pictures on the next page?

LEAFLESS TREES.

Everyone enjoys trees in summer when the leaves are green and we rest in the deep shade beneath their branches. Each morning we look at them from our windows and are as glad as the birds that they live and grow in our gardens and along the roadside.

But in winter how many young people think much about the trees? You may stand "under the spreading chestnut tree" and, unless the old burrs are on it, you cannot tell it from a maple. This is because you have never thought about trees in winter, and have not yet learned that they are well worth knowing when leaves and fruit have disappeared.

For your January study, choose a tree near your home, one that you can see every day. Look at it a few minutes in the morning, when the sunlight helps you to see every little branch and twig and the furrows in the bark. Then look at it again in the evening

FIG. 3.—*Collie.*

FIG. 4.—*Poodle.*

FIG. 5.—*Mastiff.*

FIG. 6.—*Bulldog.*

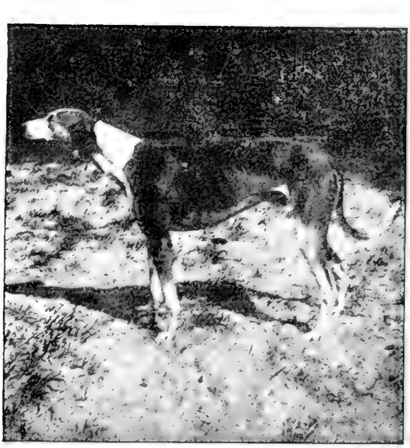


FIG. 7.—*Greyhound.*

FIG. 8.—*Bloodhound.*

by moonlight or when the stars first begin to twinkle through the open spaces in its branches. You will soon learn to enjoy the leafless trees.

In Fig. 13 you will see a tree as it looks in winter. Notice how the branches spread. Notice, too, the long, deep furrows in the bark. What tree is it?

SUGGESTIONS FOR THE STUDY OF TREES IN WINTER.

If you do not know the name of the tree you have chosen for study, I hope you will not ask anyone to tell you. In your note-books write everything that you can learn about it now. Sometime during the year the leaves or fruit may tell you the name.

2. Compare the tree you are studying with some other tree near. How does it differ in size, in shape, in the number of branches and twigs?

3. A woodman can recognize a tree by its bark. Write in your note-books four facts that you have learned from the study of the bark on your tree. What is its color? Are the furrows deep or shallow? Are they long or short? Do they extend in regular or in irregular lines? It may be that the bark is smooth. How many trees do you find near your home that have smooth bark?

4. Tell us whether there are buds on your tree. If there are, describe them. How are they placed on the branches, opposite or in some other way? How are the buds covered or protected?

BRIGHT BERRIES IN WINTER.

A short time ago I visited a Junior Naturalist Club and found the children studying five kinds of berries that had been gathered on the way to school:—barberry, Virginia creeper, bittersweet, false or climbing bittersweet and partridge berry.

The lesson was a silent one. Each child had a single specimen and was writing his observations. On the blackboard were a few helpful suggestions as follows:—

1. Where have you seen the berries growing? Did you find the specimen on a tree, a shrub, or a vine?
2. What is the color of the berries? How many colors can you find on stem and fruit?
3. What is the size and shape of the berries?
4. How many seeds do you find in one berry?
5. As you go home from school this afternoon, where will you look for the plant on which your berries grew; in a garden, in a field, or along the roadside?

When the children had finished their study of the specimens, I asked them to tell me what they had written. Here is a copy of one of the papers, prepared by a girl about ten years of age:—

"This berry is a partridge berry. It grows on a sort of vine with leaves all growing up the stem. It is good to eat but it don't taste of much. The berry is withered now and the little green leaves have dust on the top. You can see that it has been growing along on the ground, for the under sides of the leaves and stem are all earth. The berry is just like a little red potato."

It may be that many of our Junior Naturalists will be interested in winter berries. I am wondering whether you will find any this month. In Fig. 11 you will find illustrations of four kinds:—1, barberry; 2, Virginia creeper; 3, bittersweet (a nightshade); 4, false or climbing bittersweet (celastrus). If you find any of these berries have in mind the following:—

1. Which grow on shrubs? Which on vines? Have you ever seen bright berries on trees in winter?

2. Note the color of the stem of the Virginia creeper.

3. The bittersweet belong to the same family as the potato and tomato. Sometime I hope you will compare the blossoms of these plants.

4. The prettiest of the winter fruits is the false bittersweet, with its crimson and orange colors.

5. What birds have you ever seen eating winter berries? (You must not taste any berries yourself unless you know just what they are.)

OWN A GERANIUM.

In one of the cities of New York State there are over a thousand school children of whom each owns a geranium. Every geranium is marked with the name of the owner, and the boys and girls are trying to grow thrifty plants. During the Easter vacation there will be held in this city an exhibition of geraniums. Then each young gardener will want his plant to be in good condition. He will try to have it strong and well-shaped, with green leaves and bright blossoms.

We should like every member of the club to take care of a plant from now until Easter time. A geranium will probably be most satisfactory, and you will doubtless be able to get one in your own home. As soon as you have marked it with your name, write a description of the plant. How large is it? How many leaves has it? How many buds or blossoms? Is the plant well-shaped? Keep the description in your note-books until April. Then describe your plant again and send a copy of both descriptions to Uncle John. We shall be glad to publish one or two that show improvement in the growth of the plants. The following suggestions will help you:—

1. Be sure the flower pot is large enough, in which you are growing your plant.

2. Water the plant only when it is dry and you will avoid giving it too much moisture.

3. Notice whether there is plenty of good soil in the pot.

4. Turn your plant around once in a while, thus exposing all parts to the light. Then the plant will not become one-sided and all the leaves will be green. In connection with this suggestion, I wish you would make an experiment. Place a geranium in a dark cupboard. Water it when it is dry but do not let it have any light. At the end of two weeks, tell us about your plant.

A DISEASED APPLE.

Do you remember the time the doctor vaccinated you, and how he did it? I want you to turn doctor and vaccinate an apple. There will be this difference in results: you were vaccinated to prevent a disease, but on the apple you will try to produce one.

From a thoroughly rotted apple, take pieces no larger than a pin head and insert them beneath the skin of a sound apple. Keep the vaccinated apple in a warm room and in about a week watch to see it get the rot disease. This disease is caused by a fungus. You will not be able to see the fungus with the naked eye but it surely will be there.

The growth and spread of germs and fungi are very interesting studies and I am sure you will find them so if you make simple experiments.

UNCLE JOHN.

THE SCHOOL GROUNDS.

Perhaps you are already beginning to think of spring. What will you do then? You will clean up your front yard. You will rake out all the matted and tangled grass, pick up the litter and rubbish, pile up the wood in the back yard, and make the whole place look "as neat as a pin."

Now, will you not help to do the same thing for the school grounds? I am sure you will. You will want to see the grass look neat and clean, the fence straightened up, the limbs and old paper and loose stones picked-up, the holes filled. Perhaps you will want to plant a few trees or other things. But the first and most important part to do is to make the place look "spick and span."

I am sure that this will be good work for your Junior Naturalist Club. Uncle John wants to know how many clubs will try to do this. When you meet again, bring this matter up and let your secretary write Uncle John whether you will try to clean the school grounds early in spring, just as soon as the birds are coming back.

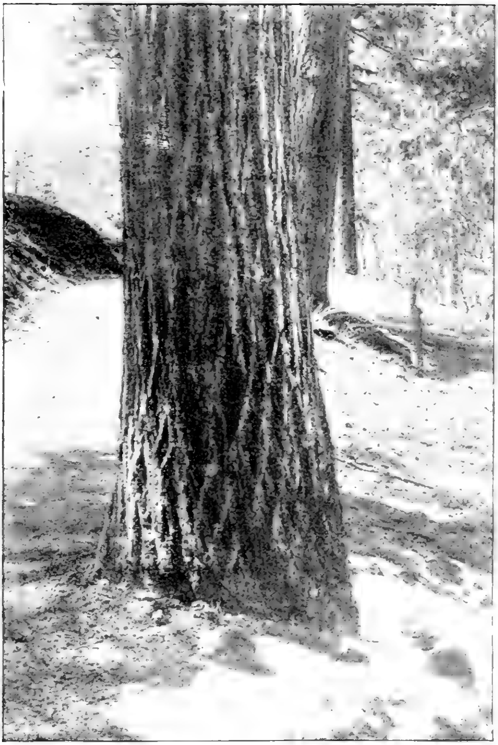


FIG. 13.—*What tree is this? Can you tell from the bark?*

Fig. 4.—*A cow grown for beef, drawn by a Junior Naturalist.*

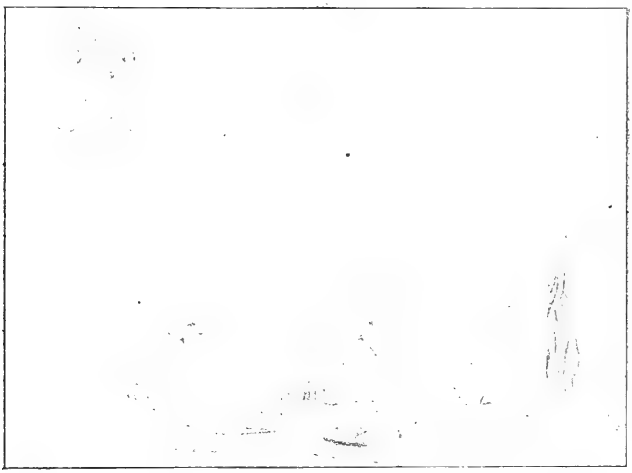


Fig. 5.—*Dot's Lily, a dairy cow, drawn by a Junior Naturalist.*

JUNIOR NATURALIST MONTHLY.

COWS.

I. P. Roberts.

> "And blown by all the winds that pass
> And wet with all the showers,
> She walks among the meadow grass
> And eats the meadow flowers."
> —From "The Cow," by R. L. Stevenson.

In the *Junior Naturalist Monthly* for December, we talked about horses and something was said about raising a calf. Now calves are nearly as nice as ponies, if you become acquainted with them. The other day I saw a calf that had long, rough hair and was all out of shape because the owner did not feed and care for it as he should. He had fed it cold skimmed milk or whey, with timothy hay but no meal. It was in a stable where the snow and wind had not been kept out by good walls. The stable was quite damp and had not been cleaned and bedded for some time. When the calf drank the cold milk in this cold stable, it shivered as though it had ague, stood with its feet very close together, and arched its back almost like a rainbow. It could not grow well, much less think of playing, when it was so cold and hungry.

Perhaps you have never raised a calf by hand. If you have plenty of new, warm milk and a warm stable in winter, or one free from flies in summer, it is an easy task to raise a calf and one can get lots of fun out of it. At first you have to deceive the calf a little, because it does not know how to keep its head down when feeding nor does it know how to drink. Four to six quarts of milk will make a good supper or breakfast. If you are not strong enough to hold the calf's head down in the pail while fooling him with your fingers, you will have to ask your father to help you.

If the calf you are feeding is raised for beef, it may be kept quite fat from calfhood until it is sold. But it may be that you want your calf to become a milch cow, so that butter can be made from the milk. If so, it will be better to feed it on skimmed milk. This skimmed milk should be as warm as the new milk before it was milked. For one or two weeks, feed the calf part new and part skimmed milk. After that skimmed milk will do nicely if you also feed it a little bright clover hay each day. At first it would be well to give it just a little corn-meal with a pinch of oil-meal in it. If the calf has too much meal, its digestion will be disturbed. Then, too, you must sprinkle the meal over the bottom of a good-sized box, so that the calf will eat slowly and mix the meal with the saliva of its mouth. Cows designed for dairy cows should not be kept too fat when young, or when they are grown they may forget to give great pailfuls of frothy milk and put the fat or tallow on their backs instead of putting butter fats into the pail. What makes the milk froth? Do you like frothy milk?

In Figs. 4 and 5, you will see two pictures of cows, drawn by a Junior Naturalist. The cow illustrated in Fig. 5 was bred and raised to produce milk; the one in Fig. 4 was bred and raised for beef. Notice the difference in the shape of the two animals.

Try to find a cow something like the milch cow in the picture. First put your hand on her to see whether her hair is soft and the skin pliable and not too thick, then run your fingers along her backbone. If it is rough, that is up-and-down, you may conclude that she has some good marks of a dairy cow. Next you can examine the underside of the abdomen for milk-veins. If these are large, then you may know that there has been a large flow of blood to the udder, to help to make the milk. When it was returned through the veins, they were not large enough to carry so much blood, so the veins swelled and became large, sometimes larger than your finger.

In the pictures, what difference do you note between the necks of the two animals? Can you go out to the stable and distinguish some of the good dairy cows from those which resemble the picture of the beef cow? If you can, then you have learned a hard and valuable lesson, and have acquired some skill in seeing what you look at. You will have to go to the stables many times and ask many questions, if you learn the difference between the good cows and the poor ones; between the beef cows and the dairy cows.

Most calves have two hard buttons on the top of their heads. These soon grow fast to the skull and then the horns begin to grow rapidly. See whether you can find these buttons. Which do you like the better, horned cows or mulleys? If you like mulleys better, when the calf is about two weeks old, shave the hair from around the button, scrape the button quite clean, and then moisten it with water. Buy a stick of caustic potash at the druggist's, moisten it a little and rub it hard on the moistened button till it becomes slightly soapy. Once is enough. Do not let the potash spread over a space larger than a five-cent piece, or you will cause a bad sore to come around the button. This is almost a painless way of making mulleys from horned cattle. It makes me very unhappy when I hear the weak cow bellowing with pain because she has been hurt by the horns of the strong boss cow. How many times do you suppose that boss cow hooks the mulley during a year? Do you think cows look better with or without horns?

When the cow-calf grows to be about one year old, it is called a heifer. When it begins to give milk, it is called a cow. How can you tell the age of a cow, if it has horns? When you are feeding the cow, see how many teeth it has for biting. How many in the lower jaw? How many in the upper jaw? The large double teeth far back in the mouth are for grinding. How many teeth has a sheep for cutting? How many has a horse? When you have learned about the teeth, tell why horses can bite the grass in the pasture closer than cows can.

If the pasture is good, the cow eats faster than the horse and then lies down. The horse lies down but little and usually in the night. Does the horse chew his cud? I wonder how many boys and girls know what is meant by chewing the cud. When the cows were wild, they ate rapidly in the morning when the wild beasts that they feared were gone to their lairs. After eating their fill, they hid away in the tall grass and ruminated, that is, chewed their cuds. They could not run so fast as the horse, so they tried to hide from their foes. But the horse was not so much afraid, so he ate when he pleased for he could run fast and kick hard. Both horses and cows retain many of the habits of their wild ancestors, when they are allowed to roam freely over the wild plains.

On which side of the cow should the milker sit? How many toes has the cow? Put your hand on the nose of a cow, on the nose of a horse, then on the nose of a dog and see whether they feel alike. Are the rabbit's feet like the cow's? Does a rabbit chew its cud? If you have a cow with black and white spots on its back, see which are longer and coarser, the black or the white hairs. How does the hen chew its food? Do cows and horses use their tongues alike when eating grass? When you examine a cow in the spring, you may find hard lumps under the skin on its back. Ask your father what they are and next winter tell us all that you can about them.

As you study cows, we hope you will occasionally make drawings of them. In Fig. 4 and Fig. 5, you will see illustrations made from drawings sent by a member of Junior Naturalist Club 586 of Bainbridge, N. Y. This club is under the direction of Mr. H. H. Lyon.

A GARDEN WORTH THE WHILE.

Last fall at Interlaken, a small hamlet near Cayuga Lake, we found a most interesting garden. The owner, Mr. A. C. Peterson, is a merchant and a very busy one, but he enjoys the "fun of seeing things grow." He planted the ground himself and took care of it outside of business hours. I know it will interest our Junoir Naturalists to hear about it.

The garden is forty-six feet by one hundred sixty-five feet. Ask your father to show you a piece of ground about this size. You will find it not very large and therefore you will be surprised when you read the following list of fruits and vegetables raised on it.

40 bushels early harvest potatoes.
30 bushels purple top strap leaf turnips.
2½ bushels fine pop-corn.
5 bushels plums, from one tree.
3 bushels apples, from one tree.
1 bushel Concord grapes.
133 pounds Hubbard squash.
50 pounds asparagus.

Now suppose Mr. Peterson had sold his garden products. Let us see what he would have received for them. Following is a fair estimate:

40 bushels early potatoes—	
If saved for seed	$40 00
If sold on market at 60c	24 00
30 bushels turnips at 25c	7 50
2½ bushels pop-corn—	
If saved for seed at $1.50	3 75
If sold on market at 75c	1 88
5 bushels plums, Lombard, at 50c	2 50
3 bushels apples at 30c	90
1 bushel Concord grapes	1 00
133 pounds of Hubbard squash at 2½c	3 33
50 pounds asparagus, average retail, 10c	5 00

In the harvest time, I saw some of the products of this garden. I went into the cellar in which they were stored. The large, solid potatoes were well worth seeing. The squashes, so heavy that I would not want to carry one far, promised something good for future dinners; the pop-corn led me to think of an open fire place with merry faces about on the coming Thanksgiving day; and the apples looked so tempting that we were glad to hear our host say: "Help yourselves." I wish our Junior Naturalists had been there. I think they would have learned that it is a good thing to have a garden.

We believe that many of our girls and boys can have a piece of ground for a garden this spring. You will have all the pleasure that comes to gardeners and perhaps you can earn some money. If you raise good vegetables, put them up attractively for the market. Doubtless your parents and neighbors will be very willing to buy them. Begin to think about this now, for soon it will be time to select the ground for your garden.

WAITING FOR THE BIRDS.

"Robin! The fields are yonder! You are my better self. I care not for the birds of paradise; for whether here or there, I shall listen for your carol in the apple tree." *L. H. B.*

A year ago I watched the springtime come on in a far-away land. I lived near a fast-flowing river in the neighborhood of high mountains. It was a beautiful country. The soft wind blew; the wild flowers bloomed; the birds sang wonderful songs, sweet and clear and long.

But I missed the home sights and sounds. I wanted to be with the robin and the bluebird; to go to the marsh where the redwings call; to seek the field where the bobolinks sing; to listen to the clear notes of the song-sparrow. Yes, it really happened that, in the land of the nightingale and the skylark, I longed for our plain little home birds.

And so this year I am waiting for them all, and as I wait I shall prepare pleasant quarters for them. It would please Uncle John to know that boys and girls all over New York State are preparing pleasant quarters for the birds. Surely Junior Naturalists will do this. Here are some things to have in mind:—

1. We shall not disturb the tangle of bushes and vines in the fence corner; the catbird may build there.

2. If pieces of string and cotton are hung out on buildings or trees, the birds may find them.

3. There should be water in our gardens for the birds to drink. They will also like to find bathing places. Tell us how you have planned for this.

4. If pussy is well fed, she will probably leave the young birds alone.

5. From my window I can see a leafless tree. In it I am going to place a bird house right away so that it will be weathered before the birds come. They do not like new wood and paint. What kind of a bird house have you made and where have you put it?

Of course, every Junior Naturalist will have one. In making your bird house, note the following:

The floor space should be about six inches by eight inches.

For wrens and chickadees the doorway should be an inch-and-a-half auger hole. For tree-swallows, or martins, the doorway should measure two inches. For bluebirds an inch or an inch-and-a-quarter. A perch should be placed beneath each doorway.

See that your bird house is out of reach of cats and other enemies.

A LETTER ABOUT BIRD HOUSES.

25 Franklin St., SARATOGA SPRINGS, N. Y.
Jan. 3. 1905.

Dear Uncle John:—

When I finished my bird house last spring, I did not set it up because the English sparrows would drive all the song-birds away and build a nest in it for themselves.

About the last of May, when all of the sparrows had built their nests, I set it up in a horse-chestnut tree in my yard. No birds came for about two weeks and then finally a pair of bluebirds made the house their home.

About four weeks after they came, I heard something chirping in the nest, so I climbed up the tree, and found two young bluebirds about two days old in it. When these were about half-grown, the old birds had another young pair. The old birds would always be watching their house and they would fly around my head and try to make me get down, when I tried to look at their little birds. They stopped until the last of September and then each pair left separately.

We thank you, Uncle John, for telling us how to build bird houses and why? Because we had learned how to take care of the birds that Colonel Brown told us about when he was in Saratoga last fall.

Sincerely yours,
WILLIE WARING.

You will not care to wait as long as Willie did to put your bird house out-of-doors, nor would I advise you to do so. If the doorway is made small enough, I think that the bluebirds will have an opportunity to occupy it.

COLOR IN FEBRUARY.

ABBIE E. COMSTOCK.

Some day after a snow storm, we want you to try to see color in the landscape. Do you think an artist would paint a snow scene perfectly white? What colors do you see in the shadow of the tree trunks? Look at the tracks you made across the yard or field; can you see any color in them? Do not be discouraged if you fail in the first attempt. Look often and at different times in the day.

Perhaps in your school work, you have painted trees trying to represent the fresh green of spring, the rich color of summer, or the bright tints of autumn. Did you ever think to look for color in the bare trunks and branches of the trees in winter? See that mass of trees at a distance; another nearer by. Look in the morning, in the middle of the day, and just at sunset. Look on a bright day and on a "gray day." What colors do you see? Are they always the same? Watch the changes in the color of the twigs as spring comes on.

We hope that you will be able to see a great deal of color this month and that you will write to Uncle John about it.

SUGGESTIONS FOR THE MORNING TALKS.

It may be that your teacher will not have time to hold regular club meetings. If not, perhaps your Nature-Study lessons can be used in the morning talks, and during the week you can use some of your leisure in writing to Uncle John about the things that interest you most. It will be well to discuss the foregoing lessons in the leaflet, and if you have time for something else, the following topics may attract you. It will be a good plan for your teacher to write the topics on the blackboard. You can then have the subjects in mind during the day and this will help you to remember them when you go home.

1. Who saw the moon last night? Was it a new moon? Was it in a clear sky or were there clouds about it? How many stars were near the moon? What time was it when you first saw the moon last night? Look to-night at the same time and see where it is.

2. How many fruit trees are there near your home? What kind are they? From the appearance of the trees, can you tell which are apple, plum, pear and peach? As you go home from school to-night, look at the branches of three different kinds of fruit trees. Do you find that the buds are arranged the same way on all of them?

Carefully break off three small twigs and show your teacher some things that you have learned by comparing them.

3. In which direction did the weather-cock face this morning? Was the wind blowing hard? Was it cold or warm? Did the wind bend the trees? Did it prune any of them? The next time the wind blows hard, notice which trees bend most easily. Which of the brown weeds growing by the wayside are most disturbed by the wind?

JUNIOR NATURALIST MONTHLY.

CATS.

"Close by the jolly fire I sit
To warm my frozen bones a bit."
—*Robert Louis Stevenson.*

It is cold out of doors these March nights. The wind howls about the eaves and rattles the window blinds. You sit before the fire and think that it is very nice to be at home. The gray kitten comes in lazily, yawns, stretches, and then sits beside you. She does not like the cold. None of her family like it. Lions, tigers, and cats enjoy life best in the warmer lands.

We want you to think about the gray kitten this month. If you have cared for her tenderly all the days that you have known her, she will give you many opportunities to study her ways. Cats, you know, are valuable farm hands. Let us try to understand them better that we may make them more comfortable and at the same time more useful.

A long time ago, I owned a gray kitten, one of the most interesting of her kind that has come into my life. She was a little waif that I met on the highway one winter night, and, although I tried to prevent her, she insisted on going my way. When I reached home, there she was beside me. It was so cold that I did not like to leave her out-of-doors, and the next day I could not learn where her home had been.

We became friendly, this little gray kitten and I, and she followed me about as faithfully as a dog. One way in which she showed her desire for my companionship, I think will interest boys and girls. It happened that for several weeks I was detained in the city until after dark, and one night, as I was returning to my home I found her standing on a corner about four blocks from the house. I picked up the little wanderer, covered her with my cape, and carried her home. The next night she was in the same place waiting for me, and this continued for weeks. Even on cold, stormy nights, the little, shivering figure stood by the railroad crossing, always on time.

When you write to Uncle John, tell him something about your cat. He will be interested to know how long she has lived with you, and whether you enjoy her more than your other household pets. He will also like to have you learn something about her that you have never known before. The following suggestions may help you:

1. There are two great classes to which cats belong, the long-haired and the short-haired. In which class would you place your cat?

2. Is she friendly with the members of your family? If not, what do you think you can do to make her feel happy when persons are about?

3. Notice whether she likes to do the same things each day.

4. Give your cat a bone with some meat on it. How does she hold it? Does she chew the meat? How does her tongue feel when she licks your hand? What do you feed your cat?

5. Notice how she uses her paws and her tongue when she cleans herself? Why does she keep herself clean?

6. How can pussy defend herself from dogs?

7. Feel the underside of her foot. When you do this, do you feel her claws? If not, why? Does a dog have claws? What does a horse have instead of claws?

8. Notice whether pussy eats slowly. Some animals hunt in packs, and when they eat, they devour their food rapidly lest their companions may take it from them. What do you think about cats? Do they go alone in search of food? Have you ever noticed whether they are in a great hurry to get rid of their food?

9. The cat, you know, belongs to the same family as the lion, which prowls at night, very often traveling by twilight. Do you think the cat enjoys hunting by twilight?

10. Watch your cat when she is walking on the snow. Does she seem to enjoy it?

11. Why is the cat a useful farm hand?

12. Every year the government appropriates money to maintain cats in the post-offices and public buildings. Why?

13. It is said that well-fed cats are the best mousers; what do you think about this?

WILLOWS.

RALPH CURTIS.

When pussy willows are out we feel that spring is near. Sometimes the blossoms appear very early. I have found them in February, but more often they wait until much later in the year. As we look at them, what memories of spring they bring! How mild the air, how warm the sunshine, how loud the sound of running water everywhere!

Are you waiting impatiently for the pussy willows to come out? It will not be long before they appear. In the meantime, you can "force" some of the blossoms in the schoolroom. Bring in a few willow twigs; two feet long is about the right size. Soak them in water to wash off the dust and soften the bud scales. Stand them in jars of water, one or two in each jar is best, and change the water every two or three days. Keep the ends of the twigs fresh by cutting off the brown, dead part so that the water can soak in easily. Repeat the first soaking every few days to keep the twigs from drying out and to take the place of the warm March rains. After a few

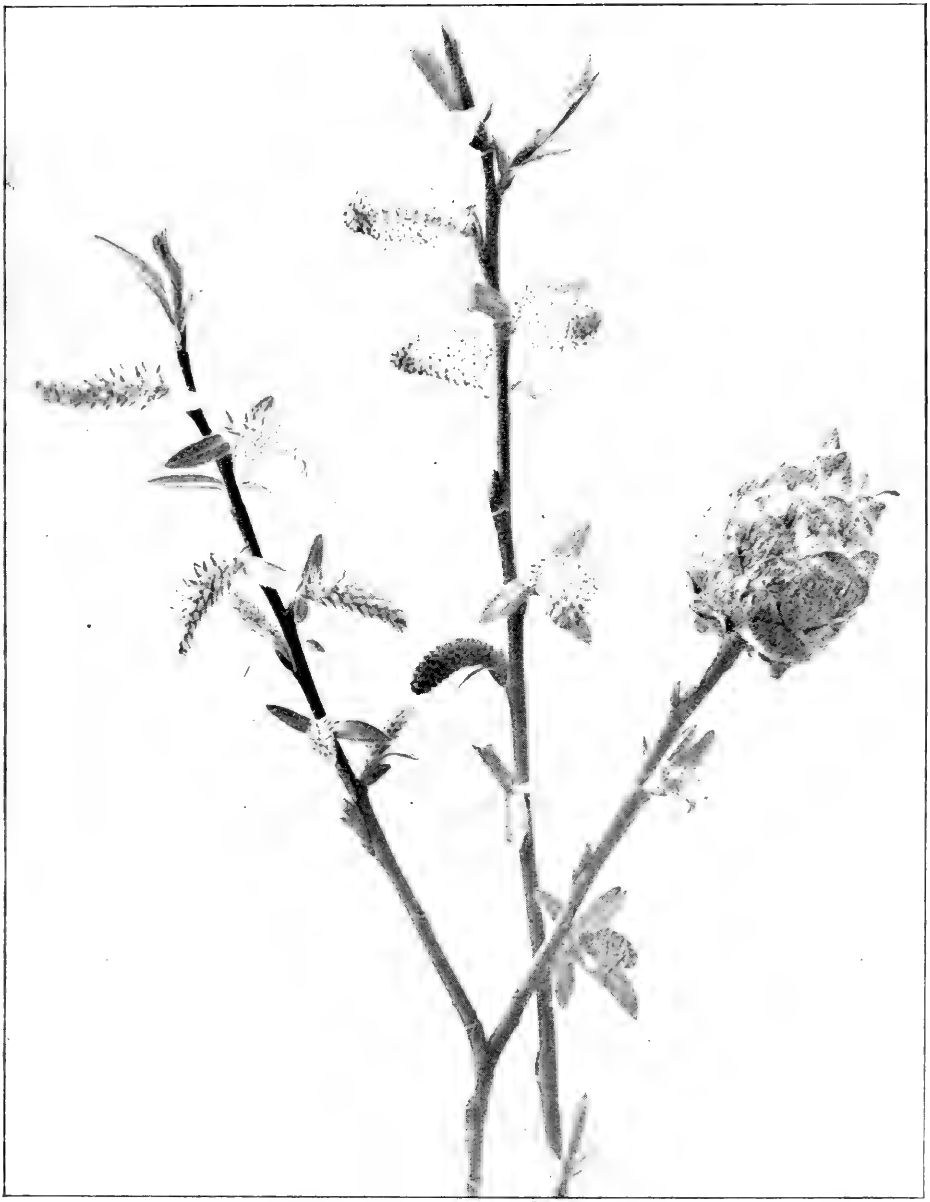


FIG. 4.—*The two kinds of blossoms found on the heart-leaved willows. How do they differ? Notice the pine-cone willow gall.*

FIG. 3.—*Heart-leaved willows.*

days the dark buds will begin to swell, soft, white hairs will peep out, and soon you will have pussy willows in full bloom, with the cold winds howling outside, and the snow still piled high in the roads.

But who will get the twigs? We all know that willows are common plants. They grow everywhere and there are a great many of them, but how many know pussy willows when you see them in the winter? Can you always tell whether a twig is a willow twig or not? Let us see how willows look as we find them in winter, and then when our pussy willows come out we can learn still more.

All our woody plants, like trees, shrubs and vines, have their leaves growing either in *whorls*, i. e., three or more at a place, like catalpas; or *opposite*, i. e., two leaves opposite each other at the same point, like maples, ashes, lilacs, and honeysuckles; or *alternate*, i. e., one leaf at one place and another higher up, alternating first on one side and then on another like climbing bittersweet, roses, sumacs, apples, pears, peaches, cherries, oaks, beeches, elms, willows and many others. The willows, then, belong to this large group of plants with alternate leaves. In the winter time, the leaves are gone, but each leaf has left a scar, and above each leaf-scar is a bud; so we can tell whether a plant had whorled, opposite, or alternate leaves by the arrangement of the leaf-scars or the buds, or the branches which grew from the buds.

Now how are we to tell willow twigs from all the other alternate-leaved twigs? This we can do by looking at the buds. It is very interesting to study winter buds. Different trees have very different buds. Notice how different a hard maple bud is from a soft maple bud; an elm from a horse-chestnut, a basswood from a butternut, or the long, pointed buds of the beech from the short, silky buds of the sumac which we have studied. We find that winter buds differ greatly, not only in size and shape, but also in covering. Some buds are covered with many small, overlapping scales, others with only a few large scales, and still others are covered with one large bud scale. This is how we can tell willows from all the rest of our trees and shrubs in the winter time. The willows are the only alternate-leaved, woody plants which have but one bud scale. Some of our willows are trees and some are only bushes or shrubs. The most common willow is the yellow-twigged willow. This tree has yellow twigs and buds which turn a beautiful bright yellow as spring advances. Of the shrubby willows, the heart-leaved willow, Fig. 3, and the pussy willow are the most common. The heart-leaved willow has pinkish twigs and buds and the buds taper to a point which curves out from the twig. The pussy willow has larger, dark brown or black buds which lie close to the twig. Perhaps you will find twigs of both of these willows.

In Fig. 4, you will see illustrated the blossoms of the heart-leaved willow. If you look closely, you will see that the blossoms are not alike. Notice whether there is a difference in the blossoms on the twigs you have "forced" in the schoolroom.

You will also see on one of the twigs in Fig. 4, a cone-like growth. This is called a pine-cone willow gall. It is not a cone, but the home of a tiny insect. You will not have any difficulty in finding the pine-cone willow galls. Take them into the schoolroom and study them carefully. Open one of them; do you find anything inside? Put a few of the pine-cone galls in a glass and tie mosquito netting over the top. Look into the glass occasionally. Later in the year when you have studied the pine-cone willow gall, we shall tell you the story of this strange insect home.

During the month of March, let us see what we can learn about willows. Following are four suggestions that will help us in our study:

1. We shall find some of the shrubby willows and break off twigs two feet long. We shall "force" the blossoms on these twigs in the schoolroom and watch what happens.

2. In looking for pussy willow twigs we shall try to find an alternate-leaved shrub with large, black, plump buds having but one bud scale.

3. When the willows are in blossom in the spring, we shall try to notice what difference there are in the blossoms.

4. We shall study the pipe-cone willow gall commonly found on the heart-leaved willow.

MY OLD WILLOW TREE.

L. H. BAILEY, SR.

Thirty-five years ago, one cold, frosty morning in January, I arrived in Decatur, Michigan. I started on foot for South Haven, 32 miles away. Reaching over a fence, I broke off a limb from a golden willow tree, and made me a cane to walk home with. I stuck the cane into the ground by the side of the well. That year it grew two feet, bottom-side-up. The next year I set it out for a shade tree on the roadside. It is now 50 feet high and three feet through and still growing bottom-side-up.

Note:—The above was written by a farmer 86 years of age. It would interest him to have our Junior Naturalists plant a willow tree from a cutting, as he did so long ago.

TEXTURE OF THE SOIL.

G. F. Warren.

Some of the Junior Naturalists collected samples of soil last fall. Perhaps you have called it dirt or earth. I think that soil is a better name for it, then we can use the word dirt to apply to dirty faces, and earth to mean the whole world. The soil is only that part of the earth on which plants grow or might be made to grow. What things could we have to eat and wear if there was no soil? Could we have linen handkerchiefs? Calico dresses? Woolen mittens? Beefsteak? Why? Could we have sealskin coats? Codfish? Those who collected samples last fall know some of the ways in which soils differ. Some are yellow and some are brown, some are hard and some are mellow, some are coarse and some are fine. This month we want you to see what you can find out about coarse and fine soils. Men who study soils call this the texture of the soil.

Did you get some sand and clay when you collected soils last fall? If you did not, then get a little of each of these and samples of other soils. Rub some of each between the thumb and finger. Which is composed of larger particles? Can you find one single particle of clay? Of sand? What other differences do you find between sand and clay?

If a soil has such a mixture of large and small particles that it is neither clayey nor sandy, it is called a loam. Sometimes one is really not a clay nor does it have enough large particles to make it a loam, so we call it a clay loam. What kind of soil would a sandy loam be? Which of these five kinds of soil is in your yard or garden? Do you think of any crops that grow best on a sandy soil? On a clay soil? Which one of the five kinds would you prefer for a garden? Which ones are sticky? Which one is used for making brick? Which makes "mud pies" best?

A FEW EXPERIMENTS WITH SOILS.

Experiment I.—Put sand in one bottle of water and clay in another. Shake each bottle. Which settles more rapidly? Why?

Experiment II.—How could you separate the different sized particles in a loamy soil? Thoroughly shake such a soil in a bottle of water. Let it stand for two or three minutes, and then pour the roily water into another bottle. Let this stand for about an hour. If the water is still roily, pour it into a pan and let it evaporate. When the sediments are all dry, compare them and see which is coarser.

Which would be deposited first by a river, sand or clay? Do you know of any stream or creek that has a sand bottom in places and a clay bottom in other places? In which place does the water run faster? What is the name of the creek?

Experiment III.—Put some pieces of lime in a bottle of water. Shake it and let it stand about a day. Pour off the clear water into another bottle. We will call this lime water. Now put a little clay in each of two bottles of water. To one bottle add some lime water. Let the bottles stand for an hour or more. What happens? We learned in the first experiment that the large sand particles sank more quickly than the small clay particles. The lime made the clay particles stick together so that they were larger and sank. Do the farmers in your district use lime on their soil? Do you see one way in which it would do good? Do you think that lime would be likely to do as much good on a sandy soil as on a clay soil? There are some other ways in which lime does good. Perhaps you will find them out sometime.

When you send in your dues, tell Uncle John about your experiments and see how many of the questions you can answer.

POULTRY.

Every morning at daybreak I am awakened by a very cheerful cock that lives in my neighborhood. He is an early riser and it is not his fault if I fail to follow his example. I would not banish him, however, for I like to hear his lusty summons. It is a pleasure to know that the poultry yard is near, and that at any time I may go among the busy little inhabitants, learning from them the interesting ways in which they spend their days.

During this month we wish all members of our Junior Naturalist Club to visit a poultry yard. Perhaps your teacher will go with you. While you are there, find out as many things as possible about the hens and chickens. Learn, too, something of the ways of the old rooster who is at all times the acknowledged master of the poultry yard.

You will notice many differences, perhaps, in the poultry that you find. I am sure you will not see two hens alike, any more than I should expect to find in your schoolroom two boys or girls exactly alike. Some hens may be brown, some white, some black, and some speckled. Some will have feathers on their feet; others will not. On many there may be high pointed combs; on others, the comb will be close to the head. Some will have long tails, some short tails, and others scarcely any tail at all. They differ in many ways.

As you look at the chickens, compare them with ducks as to their feet and bills. Which do you think can scratch better for worms; ducks or hens? In what way do a hen's feathers differ from a duck's? Did you ever notice the scales on a hen's feet? Does a duck's feet have scales? What other animals do you know that have scales on their bodies? Do all fishes, snakes, turtles, and robins?

Watch the chickens as they make their toilet. I have been told that among the tail feathers of barn fowls there is an oil sac which they find useful in cleaning their feathers. Do you know whether this is true?

Not long ago, I visited a poultry yard in which there were 40 hens and pullets and two roosters. They were being cared for by a young girl who seemed to enjoy them very much. I asked her to tell me what she did for her poultry to keep the birds looking so healthy, and to encourage them to produce the goodly supply of eggs which she had collected. This is what she said:—

"Every morning I feed my poultry at 7:30; the earlier they are fed the better, for the more hours the hen is active, the better she lays. I give them food made up of three parts, wheat, oats and corn. Then I fill a pan about the size of a large roasting tin with warm water for the little flock to drink. I always try to have my poultry well fed, to give them pure water and to see that they have plenty of sunlight and warmth and a dry, clean pen.

"In order to keep the pen clean, I remove the hen manure every day and scatter a little soil or coal ashes about. If left in the pen, the manure gives off a gas poisonous to the air. Since hen manure makes a good fertilizer for the land, particularly for the garden, I save it for this purpose.

"At 11:45 I again feed my poultry. This time I give them boiled potatoes and meal. The meal mixture contains corn meal, wheat bran, and middlings. For my 40 hens I use about eighteen potatoes. These I mash and add the meal mixture with a little water. This noonday meal is carried out to the pen and placed in a trough. In addition to the food and water, I see that there is some gravel, cracked oyster shells, and meat scraps in the pen. The meat scraps have been cooked and ground and take the place of animal food which the flock would find if allowed to roam about out-of-doors. As a special treat, I give them a little extra vegetable food, consisting of beets or lettuce. At night the food is the same as in the morning. One thing that I try to remember in feeding my chickens is to scatter the food so that they will have to scratch for it, thus getting exercise.

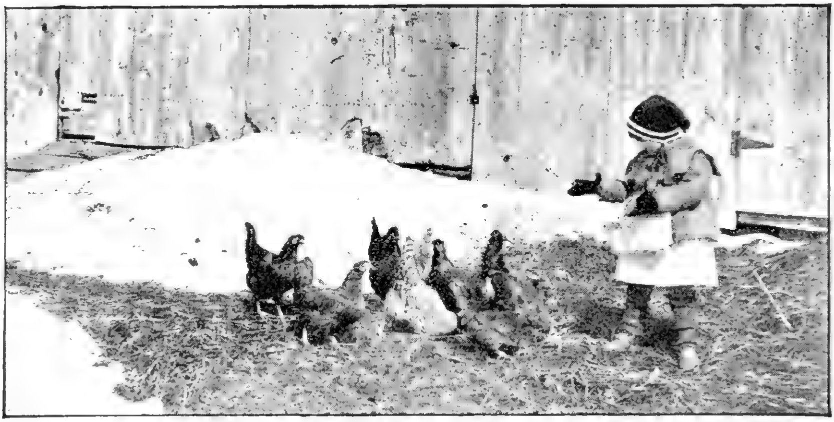
"The matter of pure air is important to poultry. During the night, I remove the glass window and put in a cloth screen. I have found that by putting in the cloth screen the air in the pen is not much colder and it is much better because more fresh air can enter through the cloth than through the glass."

You see the poultry that I visited was well cared for. I wonder how many of our boys and girls have chickens of their own. If you have, I wish you would try some of the arrangements I have described for keeping a successful flock of poultry, and I believe that you will be more than repaid for your extra labor and care. Let us know what success you have.

PROTECT THE WILD FLOWERS.

In many places the spring blossoms are disappearing. People gather them carelessly and often uproot them. Last fall we asked Junior Naturalists to suggest some way of protecting the wild flowers.

Playmates.



An early breakfast.

Blood root.

Among many good letters in response to this request was the following:

Dear Uncle John:—

In the spring I go with my father and sister to the wood to get wild flowers and I know that I would miss them very much if they should disappear, especially that queer little Jack-in-the-pulpit that I think so much of. The way I would take care of them is to be careful and not tramp on them nor pull them up by the root. I would remind other people to be careful besides myself. I am going out on a trip to the wood one of these fine days and I will find out all I can about them and get some beechnuts. Your loving niece,

EDNA.

Now that spring is here, Junior Naturalists will have an opportunity to put into practice some of their ideas for protecting the wood flowers. If you find many of one kind growing together, there is no reason why you should not gather some of them, but if there are only a few, these should be left for seed. I wonder whether you have ever noticed how much better a few blossoms look in a vase than when there are a great many crowded together.

The place to enjoy wild flowers is in the wood. When gathered, many of them fade in a few minutes. It is much more interesting to study them where they grow.

This spring we want you to watch an outdoor plant. Lest you may not be able to find it on a second visit, mark it with a stick on which you have written your name. Keep a record of its growth.

Blood root is an interesting plant to watch. Have you ever seen the leaves and blossoms develop? I shall not tell you the wonderful ways of this little plant, for I want you to find them out for yourself. Tell Uncle John all that you learn from your observation. If you do not find blood root, select some other wild plant for study.

HOW WE CAN HELP THE BIRDS.

It will not be long now until there are nestlings about us. We can help the parent birds in rearing them. The old birds know best the food and general care that the little ones need, but in many ways we can protect them from enemies and other annoyances. There are many thousand Junior Naturalists in New York State. If each one helps a little in this work, no doubt there will be great increase in the number of our song birds another year. Write to Uncle John, telling him one thing that you have done to make a bird house safe.

If you are watching young birds, remember how large you are and how small the birds are. You must approach the nest cautiously, look very quickly, and then go away. Do not have anyone with you when you make your observations. Let your first interest be in the comfort of the birds.

Arbor Day is approaching and on that day trees and vines will be planted on the school grounds. We hope that trees and vines will also be planted on the home grounds. By doing this, boys and girls will be making plans for future bird residents. In my garden, the catbirds nested in a tangle of blackberry bushes in the fence corner, humming birds built in the lilac bushes, an oriole's nest hung from the elm tree, and robins lived in the cherry tree. All in one year we had these birds and our garden was a merry place.

Look at your own yard. Would birds come to live there? Do you think an attractive yard gives pleasure to the home folks, to the neighbors, to the stranger passing by? Tell Uncle John one thing that you have done to improve the grounds about your home this year.

EXPERIMENTS WITH SOIL.

GEORGE W. CAVANAUGH.

When crops fail, there may be many reasons. The seed may be poor, or there may have been too much or too little rain; or it may be that the soil needs manure or fertilizers. Sometimes there are failures which do not seem to come from these causes. The soil about the roots of plants sometimes becomes sour or acid. Some plants will not grow well in a sour soil. If we could tell when a soil is sour and knew how to sweeten it, we might sometimes improve the crop.

Perhaps the easiest way to tell whether a soil is sour is to test it with a piece of blue litmus paper. This can easily be obtained at a drug store. Make a small hole about five inches deep in the soil to be tested, and against the side of this hole with some loose earth, press a small piece of the litmus paper. This should be done when the soil is moist enough to make the paper moist in about two or three minutes. If the paper turns a brownish red, and remains so after it dries, it shows that the soil is sour. The redder the paper, the more sour is the soil.

Some soil brought in from the field may be tested in the school house, if it is first moistened with water to make it damp. Rain water is better than well water to moisten it.

It will be interesting to see how the litmus paper acts with other things before testing the soil. Take three drinking glasses and half fill each with water. Into one put a teaspoonful of vinegar; into another one-half teaspoonful of cream of tartar and stir it, and into the third, about two tablespoonfuls of sour milk. You will find that a piece of blue litmus paper held into each of these will turn red. When reddened, take the pieces of paper out and allow them to dry.

You may now empty these three glasses or get three more clean ones and again half fill each with water. Into one put a teaspoonful of wood ashes and stir, into another a teaspoonful of baking soda, and into the third some lime water. You can get the lime from a mason or ask the druggist for a piece of hard "quick-lime" about as big as a hickory nut. Put this on a small saucer, and then slowly drop water on it, *one drop at a time,* till it gets warm and swells. After it has swelled, stir about a teaspoonful of it into the third glass of water.

Hold the reddened pieces of paper into these three glasses and see how they turn back to the blue color. Things which turn the blue paper red are *acids.* Things which turn the red paper back to blue are *alkalies.*

I think you will see now why cooking soda is used with sour milk and one reason why lime and ashes are put on soils.

HOW THE WHITE PINE GROWS.

RALPH W. CURTIS.

On my desk are some twigs of the white pine in blossom. They are very strange, these little blossoms that have responded to the warmth of my room. I wonder how many of our boys and girls have ever seen a pine tree in bloom? Let us consider how the white pine grows and bears fruit, and then you may find it interesting to watch one during the year.

When you looked at the white pine branch in winter, you found several buds clustered at the end, nicely covered by the overlapping bud scales to protect it. You also noticed other buds, the covered tips of very short side branches.

Spring comes and these tips, both of the main branch and the little side branches, begin to grow. When they begin pushing off the bud scales we say the "buds are opening." All spring these tips grow into longer and longer branches with bundles of scales along their sides. After a while, during the summer, the young tips stop getting longer and begin forming buds right at their ends. Inside a winter bud are the twigs and leaves for next year, all packed away like a telescope, ready to push out and grow big as soon as spring comes. It is by this growing on at the ends of the branches that pine trees grow higher and their branches become longer.

Every summer the white pine forms these side buds around the main end bud. Since the buds are formed at the end of the season's growth, by counting the whorls or circles of branches which grow from them we can tell how old the tree is. The distance between the whorls also show how much the branch has grown in length each year. Besides growing in length, the white pine and all other trees grow in thickness. As the tree grows older, the twigs, branches and trunk all get bigger around. Every boy knows that if a piece of wire netting is nailed around a tree, in a few years the tree will grow too big for the wire. The tree gets bigger around each year by building in a thin layer of new wood and new bark just underneath the old bark. As the tree grows bigger, the old, outside bark gets too tight and has to break open, If we go into the woods, we shall see that the bark of every kind of tree has a different way of breaking open. How many trees can you tell by the way the bark breaks open?

But to return to the yearly layers of wood; these are the annual rings which we see in the stump of a tree. By counting these rings, we can tell how old the tree is. We may see some rings thicker than others, or in the white pine, we may see that some of the whorls of branches are further apart than others. It may be that the tree was not thriving well that year, or perhaps there was not rain or sunshine enough so that it could get all the food it needed from the earth and the air.

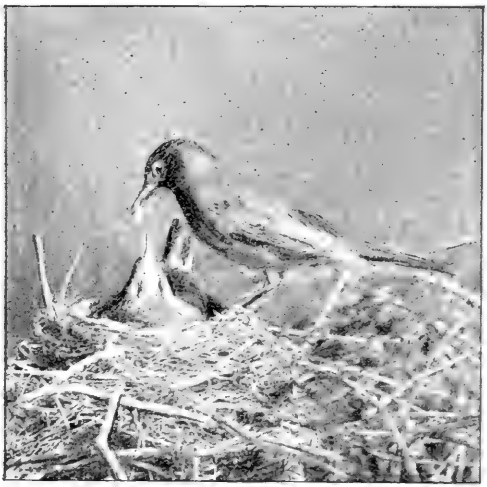
The cones grow from buds on the end of the branches near the top of the tree. These buds open early in April and by the middle of May the little cones are in full bloom. All the higher plants grow in order to bear flowers which change into seeds. Every seed contains a little plant and when the seed is made comfortable in warm, moist earth, it will break open and the little plant will grow and make a big plant like that from which the seed came.

Go out of doors and study the pines. Do you see the blossoms? What do they look like? Watch for changes that take place in them. What other trees are in bloom near your school or home?

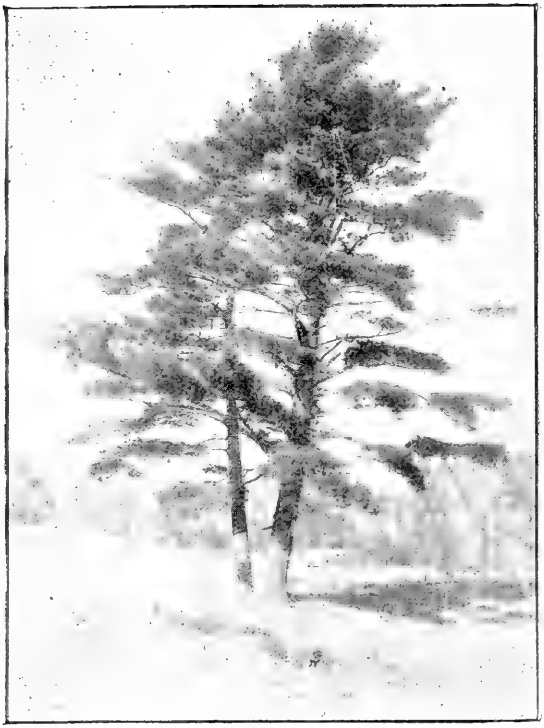
LETTERS FROM JUNIOR NATURALISTS.

All the letters sent by Junior Naturalists to the University are filed away carefully. If you were to visit Uncle John's offices you would find large boxes in which the letters are kept. Now at the close of the year we know the boys and girls that have written to Uncle John, and we also know the subjects in the leaflets that they

A safe home. What bird is this?



Nestlings. Name the bird.



The white pine.

enjoyed most. We have wanted to publish some of these letters each month, but often there was not sufficient space. Following are a few letters that I am sure will interest our naturalists and show what good out-door study some of the young people have done.

Dear Uncle John:—

I have been noticing that the tops of willow are yellow. December 7, 1904, I noticed where the snow lodged on the trees.

I have been watching a gray breasted bird with black and blue mixed in. December 15, observing how the buds on bushes and trees are so tight together. December 20, watching a rust colored bird. December 21, watching how birds drink and lift their heads up. Why is it that birds can fly when it snows and rains? Noticed that the willow trees are cracking open.

A horse can sleep when he is standing. The two fore feet are placed under him and the back straight out. A horse gets up on his back legs first. A little below the middle of the leg is a horse's knee joint.

When my grandfather's horse, Nell, comes home from any place, he goes to the back door for sugar. If it happens that no one is there he will neigh and neigh till someone comes with some sugar for him. We have a little garden of flowers in our room of many different kinds of colors.

From your niece, GRACE.

Dear Uncle John:—

I have a little pony. When she is teased she gets mad and kicks. We have a little sleigh and cart too. I have ridden her sixteen miles in one day. She has upset me in the mud two or three times last summer. She loves apples. When she was young she jumped at every stone she could see. This was before we got her. The boy that owned her lives about three miles from us. I go to see him in the summer. He goes to the city for the winter.

I received a cocoanut from the south about two weeks ago. It had a glass of milk. It came in the husk. We had a hard time opening it.

I am going to make a bird house and put it up in the trees near our house. I will get some hay and put in it too. I will get some suet and hang up. The boys have a bird house in the tree at school.

I am, sincerely your nephew, JOHN.

PICTURES FOR JUNIOR NATURALISTS.

My dear Nephews and Nieces:—

Many years ago, so long ago that there were but few railroads in the State of New York and telegraphs were something new, my teacher gave me a picture card on the last day of a summer term of school. It had a wreath of highly-colored flowers. Two birds were holding the wreath by ribbons in their mouth. Within the circle of flowers, the teacher had written her name. For a number of weeks I examined my card, counted the roses and the forget-me-nots and wondered whether the birds were carrier pigeons. After a time other interests crowded in, but, while the picture card no longer came first, it continued to have a place in my heart. To day, after fifty-five annual house-cleanings and several changes of residences, I still have that card, the joy of my childhood. The longer I keep it, the dearer it becomes.

When you are men and women you, too, will find that the treasures of your youth will become dearer with the passing years. Appreciation of this sentiment was one of our reasons for changing from buttons to pictures as testimonials for the honored members of the Junior Naturalist Clubs. By that I mean those boys and girls who have sent us four letters telling what they have seen of the common things about them.

We have found that buttons are often lost, but the pictures will appear well on the walls of your room or in your scrap-book and will be a continual pleasure to you. We have a set of eight pictures and you may choose any one that you fancy most. The little pictures, or "finders," will enable you to make your choice.

Do not make the mistake of thinking the pictures are too small to be of any value. The ones that we shall send are many times larger than the samples and are printed on the best paper. Please remember that only those who have written *four Junior Naturalist letters during this school year* are entitled to one picture. I hope it will be to the convenience of your teacher and yourselves to make an early choice, telling us the number of each required in your club, that we may have them printed so they will reach you before school closes.

Give us the address of the person to whom we are to send the pictures; also give the name of teacher and number of the Junior Naturalist Club. UNCLE JOHN.

WALL PICTURES FOR THE SCHOOL ROOM.

My dear Teacher:—

We also send in this supplement, miniature samples of three wall pictures relating to rural life. Will you make a choice of one to be put on the walls of your school room, that pupils of coming school years may regard it as a token of our appreciation of the interest and help you have given the members of the Junior Naturalist Club of 1904–5? You may have either one of the three. Order by giving the letter (A, B or C). The pictures themselves are large enough for the walls in any school room.

JNO. W. SPENCER.

SOMETHING FOR THE CHILDREN TO PLANT.

I presume that you will be making Arbor Day plans by the time this monthly lesson reaches you. The duties of that day are generally understood as meaning the planting of trees. I would not say a word that would influence any one to plant one tree less. There are many other things, however, that may be planted to as great advantage. They may be planted on your school grounds and at your homes.

I have been thinking of a list to recommend for your consideration. I have one list of roses, lilacs and that class of shrubs; another list of peonies, bleeding heart and the like; in the third list I have climbers. In all, I have about thirty different kinds of plants.

Then it came into my mind that when I was a lad I liked best to be told of a few things or given a short problem at a time. When hoeing corn, I would choose ten rows ten feet long, rather than one long row one hundred feet long. The end did not seem so far away. I do not think boy nature has changed much since my time.

If I talk to you about planting two things, you are more likely to follow my instruction than if I talk about thirty.

I shall speak about two kinds of climbers. King's palaces may be improved by vines growing on the walls. I know of some school houses—and so do you—whose appearance would be improved if a mantle of vines covered them three feet thick. The farther the building is out of sight, so much the better. Some school trustees have the notion that vines rot a building and make it unhealthy. If you find such objections in your district, you will have to give up the idea of vine planting. I would not argue the question, but you can keep up just as hard thinking as you like—thinking what you will do some day when you are trustee and children want to make the school grounds appear more attractive.

There are two forms of climbers which I will recommend. One is am-pe-lop-sis and the other is the trumpet vine. There are two kinds of am-pe-lop-sis. One is the Virginia creeper, sometimes called five-finger ivy. It is called "five-finger" because the leaf has five parts. There is another kind that appears much like it but whose leaf has three parts. *Let that kind alone, for it is poison ivy.* Another kind of am-pe-lop-sis is known as Boston Ivy or Japan Ivy. This last will cling to stone and brick walls much closer than the Virginia creeper.

The other plant, the trumpet vine, will fasten itself to stone and brick walls and also to wood. At my farm home I have a trumpet vine planted beside a long-distance telephone pole that stands near the front of the house. It makes the ugly pole appear very attractive. I have another trumpet vine at the corner of the house where the wind at times blows very hard and for that reason it does not cling to the siding. For the last five years I have let it have its own way and it has become very handsome. It has a stem or trunk about eight feet high. Instead of climbing up, the branches fall down so that the ends touch the ground, making a sort of wigwam. Beneath those drooping branches and thick leaves is a fine place for children to have a playhouse and hold receptions and parties and serve refreshments. Its only use now is for humming birds and the neighbor's hens. When the trumpet-shaped blossoms are out, "the hummers," with fast-vibrating wings, seem to be sitting on air as they thrust their bills into the heart of the blossoms. The hens are never invited nor welcome; that does not prevent them from coming, however. It is usually a hot day when they cross the road, squat beneath the dense, leafy shade and take naps. For a covering for an arbor, I prefer a trumpet vine to a grape vine.

When planting, remember two things which are important for success. (1) The soil next to a building is usually very poor. Before planting, dig a large hole and place in it a bushel or two of fertile earth. Put your vine in this rich earth and press the soil close to all the fine rootlets. (2) The other important point to remember is to water frequently during the first summer after planting. Do not put the water on in small quantities, but with a generous hand. I have seen boys flatten themselves against the side of a building for shelter during a hard rain. The same eaves that shelter a boy from the rain will shelter a vine also. After the first summer, the roots will reach far enough from a building to find moist soil.

UNCLE JOHN.

THE BROOK AND THE BROOKSIDE.

"Bubble, bubble, flows the stream,
Like an old tune through a dream."
—*Maurice Thompson.*

The long, summer days will soon be here. Become acquainted with the brook, for you will find it a most interesting playfellow during vacation days. There is on my desk a book written and by one who loved and explored a brook. Next fall, I should like to send this account of an outdoor comrade to one of the members of the Junior Naturalist Club. Who will enjoy it best? Do you not think it will be the naturalist who will make a brook book of his own? I think so; therefore, I shall send it to the one who prepares for us the best record of a brook by the first of October.

Perhaps some of you will ask what it will be best to write in your book. In answer to this, I would say, write whatever interests you most. I shall make a few suggestions that will help you in keeping your record, but you may feel free to write the story of the brook in any way you choose.

SUGGESTIONS FOR THE STUDY OF A BROOK.

1. It will be well to make a few measurements: the length of the brook; its greatest width; its greatest depth.

2. What kind of bed has the brook? Are there any stepping stones across it? Are these stepping stones flat? If so, why?

3. How does the brook appear after a storm as compared with its appearance on a sunny day?

4. Describe and name, if possible, every plant growing in the brook or along its margin. Be sure to note the trees near it.

5. Make a list of every animal that you find living in the brook. Do any live along its banks? What can you learn about these animals?

6. What is the prettiest farm or home that the brook passes? Why do you think this place the prettiest? Who lives in this home?

THE FORMATION OF SOIL.

G. F. WARREN.

The brook in the picture is "clear as crystal," so that you could see yourself in it. Are the brooks near your house always clear? Usually in the spring and after heavy rains the streams are all roily. Sometimes a stream comes out into a level place and runs so slowly that it deposits the silt and makes soil. Some soils were made in other ways. Long ago, before men lived here, a sheet of ice moved over what is now New York State. This mass of ice was so thick and heavy that it ground some of the rocks into sand and soil. This period was called the glacial period. Perhaps you can get some one to tell you more about it. But the most important way in which soil is being formed is going on all about us. It is so slow a process that you have probably never seen it. Did you ever see a "rotten stone," that is, one that would break to pieces very easily? Perhaps you have seen the tombstones in an old graveyard crumbling to pieces. What do you think makes them crumble? In time would one of them make a soil?

If you have a magnifying glass, examine some sand and fine soil with it. Notice that the grains of sand or clay, when magnified, look like rocks.

Are there any stones in the soil around your home? How did they get there? Were they brought by streams or glaciers, or are they parts of the rocks that were originally there and that have not yet crumbled into small enough pieces to be called soil? If the stones are rounded, tell how you think they became so. How was the soil around your schoolhouse formed? Was it deposited by a stream or glacier, or how did it get there?

Sometimes the soil is washed away as fast as it is formed, so that the bare rocks are exposed. Do you know of any place where the rocks are not covered with soil? Do you know of any stream that has a rock or stone bottom?

Soil is always being washed from the higher points of the field to the lower parts. Which are the more fertle, the lower lands or the higher ones? What effect does it have on the fertility of a field when the soil "washes"? In the south, farmers sometimes plow and plant around a hill rather than go up and down it, and they leave a strip of unplowed land every few rods. The water then has to run crosswise of the rows and furrows, and across the unplowed strips of grass land, so the soil cannot wash badly. This is called "contour farming." Our soils do not wash so badly, but still there is much loss.

Do you think of any way in which we might keep the soil on steep hillsides from washing? What effect would it have if the hillsides were planted to trees or grass.

THE BROOK.

A brook is the best of subjects for nature-study. It is near and dear to every child. . . . It is a scene of life and activity. It reflects the sky. It is kissed by the sun. It is caressed by the wind. The minnows play in the pools. The soft weeds grow in the shallows. The grass and dandelions lie on its sunny bank. The moss and ferns are sheltered in the nooks. It comes one knows not whence; it flows one knows not whither. It awakens the desire of exploration. It is a realm of mysteries. It typifies the flood of life. It goes "on forever."—*L. H. Bailey.*

BLOSSOM-TIME AND SEED-TIME.

"When does the chestnut tree blossom?" I asked a class of bright girls and boys. Only one of the forty knew. "When are the chestnuts ripe?" I then asked. Every one of the forty knew. I was glad to find that the chestnut tree had not wholly escaped the notice of the young naturalists, but I thought it best to encourage them to find out when the blossoms appear that make the nuts or fruit. Watch the chestnut trees this year and find out. See whether you can notice any difference in blossoms on the same tree. When the small burrs are first forming, open one and you will learn how very interesting a little chestnut appears. Do not open many, for I am sure you will wish a goodly supply of nuts next fall.

Another tree which you will find interesting when bearing blossoms and fruit is the linden tree or basswood. If a linden grows near your home, watch the time of blossoming and notice how the fruit is borne. Some of you may not understand what we mean by the word "fruit." The fruit of any plant is that part which contains the seeds. How many trees do you know in blossom-time and seed-time?

The seed-time of wild flowers is also interesting. When you take your walks in the woods during the summer, notice the wood plants gone to seed. Do you remember the little plant you marked in the spring, that you might watch what happened when it was no longer in blossom? Tell us how it goes to seed.

Notice the seed pods of the adder's tongue. How many do you find on one plant? The adder's tongue is a lily. What other members of the lily family do you know?

Have you ever seen the fruit of the Jack-in-the-pulpit? If not, I wish you would look for the bright scarlet berries all packed together upon one stalk. This bit of color in the woods is as pretty as any blossom.

Keep a list of the wood plants that you know in seed-time.

THE STORY OF A BOY, A HEN, AND SOME OTHER THINGS.

JAMES E. RICE.

This is the story of a real, live boy and a big, good-natured, cinnamon-colored hen. Both lived on a farm. They were more fortunate than many other boys and hens, because the boy's father and mother believed that young folks should have pets of their own, and pets, you know, usually receive good care.

This story begins in the spring, when wild flowers were peeping through their covering of leaves and nodding in the warm sunshine. Bluebirds and robins were singing merrily in the trees. They were looking about for a safe, cosy place to build their nests. Old Cinnamon, also had been searching for a place to "hide her nest," and she had found it too, It was under the feed manger in a vacant stall in the barn.

Nearly every day old Cinnamon visited the nest, just as quietly as could be, so that no one would see her, and laid a large, brown egg. Then she flew off and cackled so loudly that the roosters crowed and the turkeys gobbled and turned red in the face and strutted about, as if trying to see which could make the most noise. They were all happy,—it was such a glad springtime.

Each day, the boy—the boy's name, did you say? Sure enough! I have not told you! His real name was Thomas, but he was called Tom, for short; so we shall call him Tom. Tom knew old Cinnamon had a nest somewhere because he had heard her cackle. He searched and he searched until he found it. Then every night he ran to the nest as soon as he came from school, and took the egg into the house, placing it carefully in a basket, where he kept all of old Cinnamon's eggs. Each day, he turned the eggs because that was the way his grandmother did and Tom had great confidence in his grandmother; most children do, and they well may have.

One night, Tom found old Cinnamon on the nest. This time she did not fly away cackling, as was her usual custom when disturbed. She actually stayed on the nest and scolded him a little, and when he tried to feel under her for the egg, she pecked his hand. Tom did not mind this. He knew that his pet had a kind disposition and would make a good mother hen, who could be trusted to raise a nice family of chickens. After waiting a day or two, to see whether old Cinnamon would change her mind, he dusted her with insect powder, and one evening placed 15 of the largest, smoothest, most perfect-shaped eggs under her. Near by he placed some corn and oats, some gravel, a dish of water, and a large box of dust and coal ashes. This is the way his grandmother did so that her broody hen could come off whenever she wanted to eat or drink or enjoy a nice dust bath. He then fenced in the stall so that other hens could not steal the food or disturb his silent partner. Old Cinnamon was really and truly Tom's silent partner, for it was agreed that Tom should have half the money for the eggs and chickens. This money was to be his to put into his bank or to spend as he pleased. Old Cinnamon was to receive, as her share, the best of care and all she could eat.

How long it seemed to Tom, those 21 days before the chickens hatched! But how much longer it must have seemed to old Cinnamon who could not run about and play all day, as Tom could, but had to sit there patiently waiting for her little chickens to hatch! She seemed to enjoy it, however.

One night, Tom thought he heard a chicken peep. Sure enough! He was right. Then he listened close to old Cinnamon and heard it again; "Peep, peep, peep!" But he did not disturb her, because he had learned that it is better not to go near a good hen when her chickens are hatching. So he waited, and one morning, a most interesting sight met his eyes. There was old Cinnamon, right on time, as happy and as contented as could be, with one bright, little, black-eyed chicken on her back and a row of cute little heads darting in and out between her feathers all about her. She was saying, "Cluck, cluck, cluck," in such a soothing way that Tom imagined she was telling her little downy babies not to be afraid, for he was their friend.

Tom had prepared already a large, dry, clean coop where his little family might live. In front, he had a wide board on which to place the food during the day. At night, this board was raised against the coop to keep out rats and weasels. It also kept the little chicks from running out into the cold, wet grass before Tom came out in the morning. You know little chickens are early risers.

"How many chicks did old Cinnamon hatch?" How many do you suppose? "Eight?" No, guess again. Eight chickens are as many as some hens hatch, but old Cinnamon actually hatched out 11, bright, active, puff-ball babies.

What do you think Tom gave his little chickens to eat? "Corn, wheat, and oats?" No, indeed, Tom knew that they could not swallow such large grains. He gave them some bread and milk, but he was careful to squeeze the milk out. Little chickens should not have wet or sloppy food, you know. They enjoyed moist bread and old Cinnamon taught them to eat it. She picked up some bread with her beak and called, "Cut, cut, cut!" and the little fellows came running to her and jumped up to pick the bread from her mouth.

Tom always fed the chickens on a clean board or shingle, and he was careful not to give them more than they could eat up clean, for he did not want the food to get dirty and sour and make his pets sick. He was always careful to see that old Cinnamon had her share, too. On the very first day, Tom placed some fine gravel by the coop for the chickens to eat. Do you know why he did this? It was because chickens have no teeth with which to chew their food. They have, however, a place in their bodies called a gizzard, which is hard and tough and which grinds grain with the gravel until it crushes the food up fine. If they do not have any gravel or grit, they cannot digest their food easily. If you will hold a little chicken close to your ear and listen, you can hear the stones grinding in the gizzard.

After a few days, the chickens were fed a mixture of finely cracked grain and chopped hard-boiled eggs. Sometimes pot cheese was given them instead of the eggs. Cracked corn and cracked wheat and oatmeal made a splendid variety. How those chickens grew! "Did he give them any water to drink?" Yes, indeed, they had water to drink the very first day. Tom made a nice fountain out of a flower pot saucer and a tin drinking cup, which kept the chickens from falling into the water and getting all wet.

Right here is where Tom's trouble began, and it taught him a good lesson about carelessness. When he filled the fountain, in the morning, he left the pail standing there partly filled with water. When he returned, there was one of his largest chickens drowned in the water pail. How sad he felt! He knew that he was the one to be blamed. It was all because he had forgotten to take the pail away, and he told old Cinnamon that he would never be so thoughtless again.

A few days later when Tom counted his chickens, one was missing. He searched high and low for it, but it could not be found. The next day another disappeared. When Saturday came, Tom hid behind the bushes and waited for the chicken thief. There he waited and waited, until it was nearly dark and the chickens were calling loudly for their supper. Suddenly he heard a chicken scream and old Cinnamon squawked and tried to get out of her coop. Tom jumped up just in time to see Muff disappear like a flash around the corner and under the shed. Yes, it was Muff, his pet cat, that had rubbed up against his legs so innocently when he had fed her that morning. Tim, the hired man, offered to shoot the cat, but Tom thought of the little kittens with their eyes just opened, and forgave Muff. He did not trust her, however. He built a wire-covered yard so that hawks and cats could not get at his chickens. There they stayed until they were large enough to look out for themselves. The coop and yard were moved often so that the chickens could be on clean grass.

In a little while the chickens grew so large that when they attempted to get under their mother, they lifted her nearly off the ground. Then she began to wean them. Each day for a little while, she would run away, but she would always come back at night to protect her chickens. When they were old enough to go to roost and had a nice coat of feathers to keep them warm, old Cinnamon went back to roost with the other hens and soon began to lay again in the very same nest where she had hatched her little ones. "What did Tom do with the eggs?" Oh, don't ask any more questions. Perhaps some day I shall find time to tell you.

HOME NATURE-STUDY COURSE.

HOME NATURE-STUDY COURSE

LESSON I.—LEAF STUDY.

Over the fields and in the swamps I wander. I smell the weedy odor of the Indian summer. Yellow and fiery-red are the maples. Red and morocco-red are the oaks. Nut-brown are the beeches. Straw-yellow are the grasses, and brown and sere are the weeds. Each kind has its color.

And yet there are colors on the maple in the meadow and other colors on the maple on the hill. The oak on one side of my doorway is maroon-red and that on the other side is veiny-yellow, and they have been the same in all the Octobers in which I have loved them. Each plant has its color.

Floating, sailing, turning, the autumn leaves drop one by one. Content I sit in silence, and let the colors fill my soul.

L. H. Bailey.

Leaves of trees offer a natural and almost inevitable subject for nature-study during the months when they bedeck our New York hills and valleys. Yet the subject is of such a general character that it is too often taught in a purposeless and desultory way. In nature-study it is well for the teacher to have some definite purpose in her mind before she ventures to begin the teaching of a subject. If the simile may be permitted, her purpose should be the string on which the beads of her pupils' observation are to be strung. Mere haphazard observations may be of little value to the child. Therefore, let us consider for a moment some of the objects, pedagogically speaking, which we should strive for in beginning the study of leaves.

Leaf Study in the Primary Grades.

In primary grades, this study should be largely a question of color and form. Let the pupils collect leaves and classify them first according to colors. The autumnal tints offer a most excellent opportunity for training a child's eye to detect various shades in color. Later, let the pupils classify the leaves on the basis of form. This is of great value, for it teaches them that no two leaves are exactly alike, and in beginning to observe, nothing could be of more value than this idea of the infinite variety of Nature. This observation on leaves by the primary children may also afford subjects for drawing with colored crayons or water color, and also for paper-cutting during busy-work periods.

QUESTIONS ON THE USE OF LEAVES FOR PRIMARY WORK.

1. What method would you pursue to get the children voluntarily to note the different colors of leaves?

2. Would you have a young child attempt to sketch a leaf free hand, or would you allow him to place it on the paper and outline it with a pencil before coloring? Give reason for answer.

3. If you use colored crayons, would you have the complete leaf colored, or would you indicate the colors, by the outline and veins,— that is, outlining a red leaf in red crayon, etc.? Explain why.

4. In paper-cutting, would you let pupils select a paper colored like the leaf, or would you have them cut white paper and attempt to color it?

5. Would you teach to children in the primary grades, the name of the tree in connection with the leaf? If so, how?

6. What language work would you develop in primary grades in connection with the study of leaves?

7. What methods would you use to get the pupils voluntarily to classify the leaves according to color and form?

THE STUDY OF LEAVES IN INTERMEDIATE GRADES.

With the older children, the study of leaves naturally leads to the study of trees. The child naturally compares and classifies leaves according to form and color and soon discovers that many trees have the same shaped leaves; and thus he discovers for himself the meaning of a species or kind. This classification should not be imposed upon the pupil, but he should be led naturally to notice the likenesses and differences.

AN EFFECTIVE FIELD EXCURSION.

Leaf study affords an excellent opportunity for a short, sharp, effective field excursion. Many teachers look upon the field excursion as a difficult voyage between the Scylla of hilarious seeing and wild questionings and the Charybdis of pupils lost or strayed or being brought home with broken limbs. All this is quite unnecessary if the teacher plans the work before starting, so that the pupils know what they are sent to see, especially if the teacher leads by doing the same work that she requires of the pupils. One recess period is sufficient in any school in New York for an excursion to study leaves, except perhaps a few situated in congested city districts.

THE FIELD NOTE-BOOK.

The field excursion naturally suggests that greatest of all helps in nature-study, the field note-book. The teacher should by no means compel the children to have these note-books, but she herself should have one which she evidently prizes and uses constantly, and very soon she will find that the children will follow her example. Any little blank book with a pencil tied to it will do. We have in our possession some most interesting pupil's note-books that were blank account books of the family grocer. It must be remembered that the spirit in which the note-book is kept is more important than the book or the manner of keeping it. I have examined many field note-books kept by children of the intermediate grades which were full of interesting observations and graphic illustrations, and were precious beyond price to their owners. Such a note-book is a veritable mine for the teacher to work, in securing from the pupil voluntary and happy exercises in language and drawing. Such a note-book, however, should be considered the personal property of the child and should never be criticised except by way of encouragement no matter how crude it may be at first. The teacher should use it merely as a friendly gate which admits her to a knowledge of the child's interests and observations. If children could keep their note-books, they would prize them greatly in later life.

In order that you may realize the value of a field note-book, I shall ask each pupil of the Home Nature-Study Course to keep such a book for the work this year. Write your observations freely and informally in this book and from it make up the lessons that you send to us.

LESSONS ON LEAVES.

For leaf study an ordinary blank book not smaller than six by eight inches will do very well. Take such a book to the tree nearest your house and observe for ten or fifteen minutes, trying to cover the following points:

1. Describe the shape of the tree in a few words,—that is, whether its trunk is bare for some distance, or whether the limbs grow near the ground, and whether the branches at the top are spreading or close, and the general shape of the outline of the tree (slim or broad).
2. Where on the branches are the leaves borne?
3. Are the leaves opposite each other on the twigs?
4. Is the leaf rough and hairy, or is it shining and glossy?
5. What is the color of the leaf above? Beneath?
6. Has it changed color since summer?

7. Give approximately the length and the width of the largest leaf that you happen to see; of the smallest leaves on the same tree.

8. Are the other leaves of the tree the same size and shape as the one you are studying?

9. Is the leaf stem (petiole) long or short?

10. Is there a bud in the axil or junction where the petiole joins the twig?

11. What sort of an edge has the leaf?

12. What is the character of the veins of the leaf,—that is, does each vein branch off from the midrib or do the veins themselves branch?

13. Do the veins extend to the edge of the leaf, and, if so, do they end in a point of the leaf or at the base of a notch?

14. If the tree has fruit, gather a specimen to press or to draw in your note-book on the page with the leaf you have studied.

15. Bring the leaf and the fruit indoors with you and either press them and fasten them on the page opposite your notes or make drawings of them.

16. Place under them the name of the tree from which they came.

Please complete these exercises and send the results to us, giving the length of time necessary for you to make these observations. If you are teaching, try it with your children and note if you need more than one excursion for them to complete these exercises and if so, how many.

All of the trees in the neighborhood may be studied in this way, and after a little the pupils will themselves carry the problems home, and will thus have started the work of tree study in a practical way.

LESSON II.—SEED DISTRIBUTION—WEEDS.

The very interesting and delightful subjects of seed dispersion is usually taught wherever nature-study is a part of the school curriculum. However, it is too often taught as a fact unrelated to plant life. If a seed is transported by parachute or wings, or by attaching itself to the fur of animals, there are reasons for it which are vital to plant life. In teaching the various ways that seeds are developed for transportation, the following reasons should be thought of and studied:

1. The sole object or end of a flower in nature is to develop seed. The children are likely to think that the plant exists for the sake of the blossom, whereas the blossom exists for the sake of the seed. In the case of annuals and biennials, the production of seed is the climax to the plant's life and the plant dies soon after.

2. If the seeds all fell near to the parent plant, the young plants would be so crowded that many or all of them would starve,—exactly as if a family of a dozen children were compelled to sleep in a bed large enough for one, and to live upon the bread and butter which would be sufficient to nourish just one individual.

3. As plants are stationary and cannot move about and select favorable positions in which to plant their seeds, the seeds must find such positions for themselves, and in order to do this nature provides that they must travel.

4. As a seed has to take its chances, so to speak, of being dropped in a favorable situation for growth, it is perfectly evident that where one succeeds hundreds are likely to fail. Therefore, the plant must develop many more seeds than would be necessary if it could walk about like an animal and take care of its young. In this connection, it should be noted that some animals, as the moths and butterflies, the toads, frogs and fishes, and many sea animals, lay very many eggs, letting the young take care of themselves. Whenever the young are thus left to care for themselves, many are destroyed and but very few survive, and therefore many eggs are necessary.

In studying the methods of seed distribution the following classification is usually followed:

Seeds shaken out by the wind.	Poppy Lily Seeds from cones	Chestnuts Beechnuts
Seeds that are carried by downy or fluffy appendages. ("Balloons.")	Dandelion Thistle Cat tail	Milkweed Willow Poplar
Seeds with wings.	Maple Box elder Ash Elm	Hop tree Catalpa Ailanthus
Seeds snapped out of their receptacles.	Witch hazel Violet Oxalis or wood sorrel	Jewel weed Garden balsam
Seeds blown over bare fields or snowy fields.	Locust Many grasses Weeds whose stalks stand above the snow	Wild carrot Honey locust pod
Seeds carried by birds.	Blackberry Raspberry Poison Ivy	Virginia Creeper Cherries Juneberry or shad-bush

Seeds used for food and then carried by squirrels and other animals.	Nuts Berries Grains.
Seeds that attach themselves to animals and to clothing.	Burdock Stick-tights. Pitch-forks Clot-bur

QUESTIONS.

1. Why have plants developed devices for scattering seeds?

2. What is the utility of the flower?

3. Describe or picture the poppy pod, showing by drawing or description how the seeds are scattered.

4. Show by drawing or description the development of the dandelion seed in the flower.

5. What is pappus and where does it grow in the flower?

6. Describe the pappus of the flower of the thistle, and also as it looks when it is carrying the seed. Notice that each division of the pappus has fringes along its sides. Show by sketch the difference between the dandelion balloon and the thistle balloon.

7. Show by description or by picture the arrangement of the seeds in the milkweed pod, and the position of the silk which later makes the balloon. Is this silk pappus?

8. What other seeds do you know that sail by balloons?

9. If you have ever burst a pod of the touch-me-not or jewel weed, tell how it scatters its seeds.

10. What is the mechanism by which the witch hazel throws its seeds for several yards?

11. Sketch or describe some seeds with wings. Describe the texture and venation of the wings.

12. Do you know of any winged seeds that grow on low plants?

13. Why is the winged seed's shape adapted to the needs of the tree?

14. What plants do you find being blown about the bare fields in November or later in the winter?

15. Make an experiment by taking a pan of water and placing upon it the seeds of milkweed, thistle, willow and cat tail, and note how long these seeds will float before they sink.

16. Which of the above named seeds would be likely to be planted by the water, supposing they floated upon it?

17. Make a cross-section of a cranberry and draw or describe the interior and explain how it floats.

18. What birds are most active in scattering the seeds of berries?

19. Study a bur of a burdock and find how many seeds each bur contains and how they are situated. Sketch one of the hooks of the bur.

20. The blossom of a burdock and of a thistle are not unlike in general appearance. Explain the difference between the utility to the plant of the spines on the burdock and those on a thistle blossom. Study the stick-tight or a pitch-fork and notice where the seed is and where the hook is, and describe how the burdock differs in these respects.

21. In this connection, the teacher has a good opportunity to determine for herself that appearances often are deceitful. Thistle seeds travel by balloons; but do all kinds of thistles spread themselves freely by this means? Make a careful study of the Canada thistle. How many good or fertile seeds do you really find in each head? How else does the Canada thistle spread itself? Why are Canada thistles found in patches and the bull thistle not?

22. The burdock and many others were introduced to America from Europe. Write a short imaginative story of how the first burdock seeds were brought across the Atlantic.

23. How would you teach seed germination in connection with seed distribution?

CORRELATION OF SEED DISTRIBUTION WITH GEOGRAPHY WORK AND LANGUAGE WORK.

Perhaps no one subject in Nature-Study touches geography at so many points as does that of seed distribution.

In a way, every seed that floats is a voyager and a geographer, for if the geography does not afford the seed a fitting environment it cannot grow. If a "thistle-blow" falls in a pond or is driven into dark woods, it will not produce a plant, for it must have dry soil and sunlight in order to develop. The reason why wild carrot grows by our roadsides and in meadows and not elsewhere; and the reason why daisies grow on our upland meadows and pastures and roadsides, and why the Canada thistle grows in a meadow, are all questions of geography. That the water lily seeds are distributed by water and that the plane tree grows mostly by streams, and almost every other fact of plant life, is a matter of geography.

Many of our weeds are introduced from Europe and it is a profitable line of speculation for the children to imagine how these emigrants stole their passage across the Atlantic. To think of these things specifically will help develop a geography imagination, which is absolutely necessary for a comprehension of geographical ideas.

I would suggest the following topics for an exercise in geography and language work, either written or oral:

(a) How a Shetland pony might have planted the first burdock seed in New York.

(b) The voyage of a dock seed which grew in New York and was finally planted near New Orleans.

(c) How the Queen Anne's lace (wild carrot) was smuggled over from Europe.

(d) How the poison ivy berry was carried from New York over the Rocky Mountains.

(e) Why the wild cherry trees are planted along the fences everywhere in New York State.

CORRELATION OF SEED DISTRIBUTION WITH ARITHMETIC.

While this question of correlation may easily be overdone, yet the practical side of seed distribution actually requires some arithmetical computation. As I am writing this, I hold in my hand a milkweed pod that contains, as I have counted them, 142 seeds, and there were four other pods similar to this on the plant from which I took the pod. A flourishing milkweed plant requires approximately a foot square of ground. It is quite inevitable that I should compute how many square feet of ground the seeds from this one plant would cover supposing they were all developed.

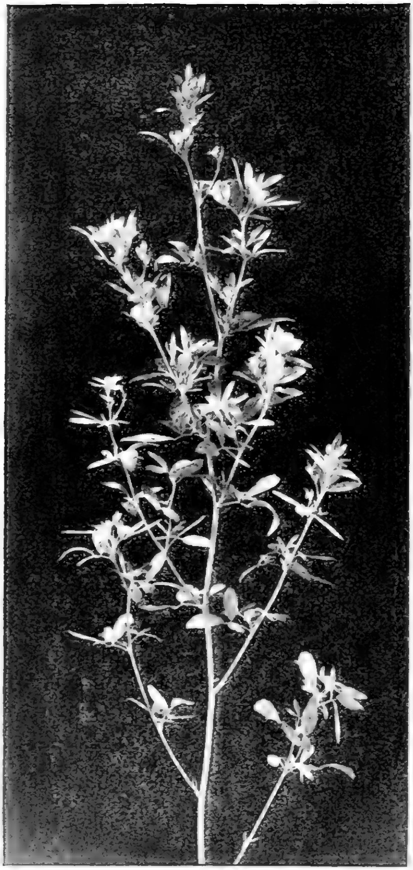
In school, such work should not be idle speculation, for the whole question of weeds and weed seeds is one that threatens the rural districts anew every year. The carelessness of allowing a single weed to grow when it might easily be cut before its seeds are developed, is what stocks our roadsides and meadows with these thieves of the plant world. I know of no more practical lesson for the farmer boy than to let him count the seeds in one blossom of the dandelion and multiply that by the number of blossoms on the plant, and then estimate how long it would take one plant to stock his father's farm.

LESSON III.—THE CHIPMUNK.

Chipmunk is a friendly little creature to those who evince a friendly spirit toward him; and he will make his home under your house or barn or even in your dooryard if you are thoughtful enough of his comfort to refrain from keeping a cat. For years there has been a chipmunk family within a few yards of the Insectary on the Cornell

4. *Wild aster, one of the characteristic plants of the American autumn.*

6. *The common chipmunk.*



7. *Sprig of the alfalfa plant.*

9. *The alfalfa "root and branch."*

Campus, and every year the mother of a small family introduces her little ones to the privileges of this house, which is supposed to be reserved for the insect inhabitants of its conservatory. Almost any day in May or June those of us who go out and in, encounter one or more of these youngsters running about beneath our feet with a faith as yet unbroken of contact with a world where only the fit survive.

Chipmunks are more easily tamed than red squirrels and will soon learn that pockets may contain nuts and other things good to eat. To see one of these little striped fellows searching the pockets of his man friend is one of the prettiest sights I have ever witnessed.

The first tame chipmunk of my acquaintance belonged to a species found in the California Sierras. He was a beautiful little creature who loved to play about his mistress's room, with every nook and corner of which he was familiar. His mistress being a naturalist as well as a poet, was well able to understand her little companion, and the relations between them were beautiful to witness. He was very fond of English walnuts and believed that every nut in the dish on the table was meant for him, and he always worked hard at hiding them until the dish was empty. One day his mistress in taking off her bonnet after returning from church, discovered several of these nuts tucked safely in the velvet bows; the nuts were invisible from the front but perfectly in sight from the side. Even yet she wonders what the people at church that day thought of her original ideas in millinery adornment, and she wonders still more how Chipsie managed to get into the bonnet box without apparently disturbing the cover, which was always kept carefully closed to keep him from taking too many liberties with the contents.

A LESSON ON THE CHIPMUNK FOR FOURTH TO SEVENTH GRADES.

Make the field note-book the basis for the work. Ask for notes that shall cover the following list of questions. After the observations have been made as far as possible (that is, for a month or two), ask for a written or an oral exercise which shall combine the personal observation in the field note-book and such information as the pupil may be able to obtain in the books which are at his command.

I wish the students in the Home Nature-Study Course to follow this plan. Observe as far as possible and place the results in your field note-book and answer the following questions, or write me a short essay that will cover the points raised by the questions.

QUESTIONS ON THE CHIPMUNK.

1. What are its colors above and below?
2. How many stripes has it and what are the colors of the stripes, and how far do they extend on the back?
3. Compare the tail of the chipmunk with that of the red squirrel, and state, if you can, the reason for this difference, for there is a good reason which has its basis in the different habits of the two animals.
4. How does the chipmunk carry food, and how does it differ from the red squirrel in this respect?
5. Does it store food for winter use?
6. What is its food? Describe how it prepares it.
7. Does it come out of its nest during the winter?
8. How does it differ in this respect from the red squirrel?
9. Does it live in the same home in the winter as in the summer?
10. How far from the ground on the tree have you seen a chipmunk? Does it pass from one tree to another by jumping from bough to bough?
11. Where is its home and how is it made?
12. Why is it not easily found?
13. What are its enemies?
14. Does it do any damage to crops?
15. At what time of the year do the young chipmunks appear?
16. What seeds do the chipmunks distribute?
17. Tell any personal experience you may have had with chipmunks.

LESSON IV.—ALFALFA OR LUCERNE.

The alfalfa plant is just now coming into great prominence in New York State. Every teacher, particularly in the rural schools, will need to know the plant and to have some information about it.

What alfalfa is.—It is a clover-like plant. It is perennial. It has violet-purple flowers. It sends up many stiff stems, 2 to 3 feet high. The roots go straight down to great depths. We studied alfalfa and clovers in our lesson of last June.

Why it is important.—It is an excellent cattle food, and cattle raising for dairy purposes is the leading special agricultural industry in New York State. In fact, New York leads all the states in the value of its dairy products. Any plant that is more nutritious and more productive of pasture and hay than the familiar clovers and grasses will add immensely to the dairy industry, and therefore to the wealth of the State. Alfalfa is such a plant. It gives three cuttings of hay year after year in New York State, thereby yielding twice as much as clover does. In nutrient value per acre it ranks above clover as 24 ranks above 10. When once established it withstands droughts, for its roots grow deep.

Alfalfa is South European. It was early introduced into North America. It is known to have been grown in Northern New York as early as 1791. But it first came into prominence in the semi-arid West, because of its drought-resisting qualities, and now it has added millions of dollars to the wealth of the nation. Gradually it is working its way into the East. It is discussed in the agricultural press and before farmers' institutes. Last year the College of Agriculture offered to send a small packet of seeds to such school children in New York State as wanted to grow a little garden plat of it. About 5,000 children were supplied. The teacher must now learn what alfalfa is.

In nearly every rural community, sufficient alfalfa can be found for school purposes. In many places it has run wild along roadsides. *If you cannot find a plant of it, we will send you a fresh specimen for study, if you apply before cold weather comes.*

On these plants make the following observations:

1. Under what conditions have you found alfalfa growing? How did the plant come to grow there,—sown, or run wild?
2. Describe the form of the root. How does the root branch?
3. Do you find little tubercles or nodules on the roots? On what part of the roots? How large? How numerous?
4. The crown of the plant (at the surface of the ground),—describe it, and how the tops and the roots start from it.
5. The stems,—how many from each crown, whether erect or prostrate, how they branch.
6. The leaves,—simple or compound? Form? Edges entire or fine-toothed? Do the leaves "sleep" at night, as those of clover do?
7. Do you find any distinct spots on the leaves? What do you think is the cause of them?
8. Flowers,—how borne (whether singly or in clusters), color, form, resemblance to any other flowers you may know.
9. If possible, find the seed-pods and seeds, and describe.
10. Make inquiries as to whether alfalfa is becoming well known in your vicinity.

AGRICULTURAL ACCOUNT OF ALFALFA.

You may be asked some practical questions about alfalfa; therefore we give you a brief agricultural account of it. If you desire further information, write to the College of Agriculture, Ithaca, N. Y., for Bulletin 221, "Alfalfa in New York."

Alfalfa is grown mostly for hay. It is not adapted to pasture, because the new growth springs from a crown at the surface of the ground, and if this is destroyed the growth will not be renewed vigorously. New York is a hay-producing state. Grain feeds can be grown more cheaply in the West. It is of great importance to the state, therefore, if a better hay-producing plant can be found. We have seen that New York leads the states in dairy cattle. Other livestock also is abundant. Last year more than half a million horses and mules were fed in the state.

Success has not attended efforts to grow alfalfa in all parts of New York. This is due to two principal reasons: (1) farmers have not known the plant and its habits well enough to give it the care and treatment it demands; (2) the soils of many localities, because of their physical condition or composition, are not suitable for the plant.

The alfalfa seedling is not a strong plant. It cannot compete with weeds nor overcome adverse conditions of moisture; it cannot adapt itself to conditions resulting from poor preparation of land, and it is not vigorous in its ability to get food from any source. Care must be given to the preparation of the land in order that sufficient moisture may be supplied during the early stages of growth and that there may be an abundance of quickly available plant-food. After growth has started, alfalfa has the power to get some of its nitrogen from the air through the nodules which grow upon its roots; yet during the early stages of growth it is essential that the soil be supplied with all elements of plant-food in available form.

While alfalfa requires an abundance of moisture for its best growth and development, yet it will not grow in soils that hold water for any considerable length of time. Such soils are usually those with an impervious subsoil or hardpan, or those of clay or silt structure which retain free water to the exclusion of air. Therefore, it is important that alfalfa soils be well and uniformly drained, either by natural conditions or by underground drain. One other essential of prime importance is that the soil be neutral or alkaline in its reaction; in other words, that it contain no free acid. Limestone or blue-grass soils are ideal in this regard for alfalfa. If acid is present, the difficulty may be corrected either wholly or in part by the application of 500 to 2000 pounds of lime per acre.

As in most other legumes (members of the family Leguminosæ, including peas, beans, clovers), there is a peculiar relationship existing between the plant and excrescences or nodules upon its roots. These nodules are essential to the normal growth and development of the plant. They contain bacteria, and these bacteria have the power of "fixing" or appropriating the free atmospheric nitrogen in the soil. Legumes are "nitrogen-gatherers," whereas most other plants secure their nitrogen only from decomposing organic matter. Failure to have the soil inoculated with the proper bacteria for alfalfa is the cause for many failures with the crop. In most instances when the plants do not make satisfactory growth or have a yellow, dwarfed appearance, the trouble can be traced to the absence of these bacteria from the soil, and hence to a lack of nodules upon the roots. The relationship existing between the plant and the organism is one of mutual benefit. Each kind of leguminous plant usually has its characteristic bacterium, which grows on no other plant, although this question is not yet thoroughly understood.

Farmers are becoming aware of this requisite in alfalfa culture and usually supply it in two different ways. The older method is to take the surface soil from an old alfalfa field, where the plants have grown well and where nodules are to be found on the roots, and to sow it on the land to be seeded, at the rate of one hundred or more pounds per acre. In this way the soil becomes inoculated with the bacteria, and as the young plants spring into growth the bacteria develop on the roots. Another method is to inoculate the seed before sowing with artificial cultures of the bacteria. Both of these methods are usually successful, and if soil conditions are right the chances for failure are few.

Alfalfa should be cut when it opens into flower. At this time the stems and leaves contain their highest percentage of nutrients, the leaves do not so easily fall off in curing, and the stems are not so woody. Besides these reasons, if cutting be delayed until after flowering, the plant may not spring quickly into subsequent growth.

Disease does not spare the alfalfa plant. Both leaves and roots are attacked. This year the most serious disease seems to be a brown or rusty spot occurring in great numbers on the leaves. The disease depletes the vigor of the whole plant and the leaves drop prematurely. No satisfactory treatment has yet been found.

Not only is alfalfa worth more in New York as a forage plant than as a seed producer, but the climatic conditions here do not seem to be conducive to seed production. Moreover, if the plant is allowed to produce seed it will not spring into growth until the following year. Consequently our seed supply comes mostly from the middle and far West, and with it is often mixed the very minute dodder seed. Dodder is a parasitic plant. Its seeds germinate in the soil, but when the plant has attached itself to the alfalfa its stem connecting with the soil dies. The dodder clings so closely to the alfalfa stem that it is difficult to kill. It should not be permitted to go to seed. Dodder is becoming a serious pest in New York alfalfa fields, and farmers should be very careful to sow no alfalfa containing dodder seed. The College of Agriculture will undertake to determine dodder seed in any samples of alfalfa seed sent in by the farmers of the state.

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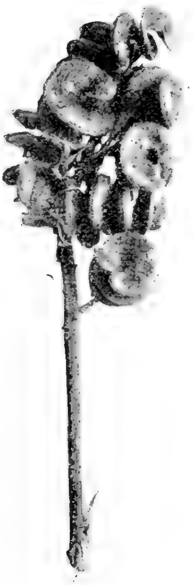
A certificate will be granted to those who satisfactorily complete ten lessons or the year's work.

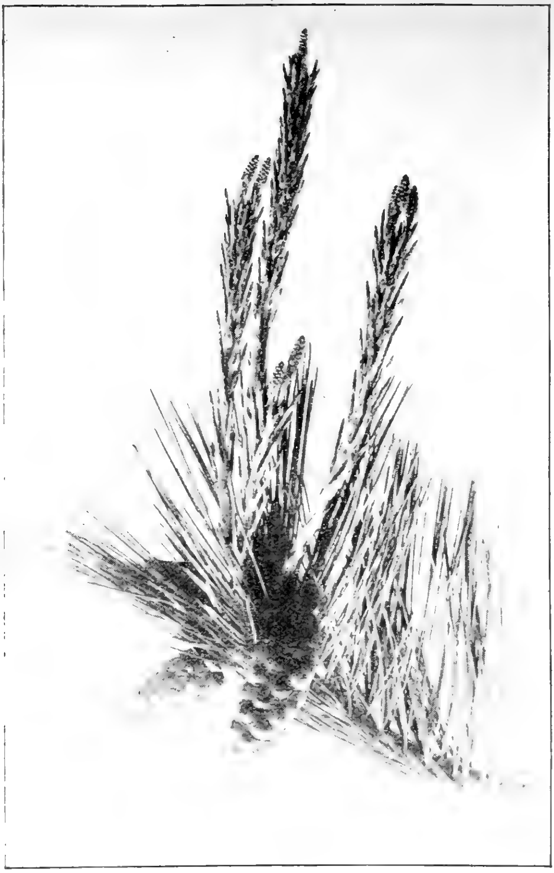
Address all communications to the Editor.

8. *Crown of alfalfa.*



11. *Alfalfa pods. How much enlarged?*

13. *Leaf of alfalfa. What significance have the spots?*



White pine showing young and mature cones.

Hemlock showing young and mature cones.

HOME NATURE-STUDY COURSE.

THE EVERGREENS.

Spite of winter, thou keep'st thy green glory,
Lusty father of Titans past number!
The snow-flakes alone make thee hoary,
Nestling close to thy branches in slumber,
And thee mantling with silence. —*Lowell.*

Not only are the evergreens among our most useful and valuable trees, but they are also most beautiful to look upon; in the winter they give us masses of color in the snowy landscape, and in the summer they add great richness and beauty to the hues of the woodlands. These evergreens are the aristocracy of the tree world; they represent the oldest families, for members of the group to which they belong appeared as early as the Silurian age; the evergreens were probably at their height in numbers of species and magnificence of development during the Triassic period. The pines were contemporaries of all those plants which were put to sleep in the Devonian age, in our coal beds of to-day. The evergreens are a dignified remnant of an older tree-race, which is being pushed to the wall by those upstarts, the oaks and maples and other deciduous trees. They still cling to the sandy shores where there is little to support other trees; and to the mountains and northern regions where other trees have not the strength to endure. Perhaps it is because they belong essentially to another geologic age when the climate was far different than our climate of to-day, that they do not shed their leaves in winter like the adaptable deciduous trees.

There are so few of the evergreens in any locality that it is easy to learn all the species present, and in this lesson we will study those species most common in New York State. We will discuss the pines, the tamaracks, the spruces, the cedars, the firs and the hemlocks.

There is one fundamental difference between the evergreens and other trees, which has given rise to some hard botanical names. The ovule is a little body that by the help of pollen ripens into a seed. Most plant species, like the apples, the maples and the sweet-peas, etc., have these ovules in a closed receptacle, which is called the ovary, where they ripen protected. Such plants are called Angiosperms, which means "hidden seed." The cone-bearing plants or evergreens bear these ovules naked, simply lying between the scales of the cones, and they are called "Gymnosperms," which means "naked seed."

LESSON ON EVERGREENS.

1. How do evergreen trees grow?
2. What is the leader?
3. How does each year's growth affect the height of the tree and length of branches?
4. If a branch on a tree is ten feet above the ground now will it be still higher twenty years from now?
5. Do evergreens shed their leaves? When?
6. Is the vegetation under evergreen trees the same as under deciduous trees? Why?

Take any cone whatever for this lesson.

7. What is a cone? What is its shape?
8. What sort of a flower is a young cone?
9. How many scales are there in the cone you are studying?
10. Show by a sketch or description the shape of one of the cone scales and its markings.
11. How are these scales arranged in the cone?
12. Where are the seeds in the cone? How are they distributed?
13. How are the evergreens useful to birds?

TABLES FOR DETERMINING OUR COMMON CONE-BEARING TREES.

A. Leaves drop off in winter. *Larch.*

AA. Leaves remain on trees all winter.

B. Leaves in bundles enclosed in a short sheath at bottom. *Pines.*

BB. Leaves opposite or in whorls.

C. Spray flat. *Arbor vitæ or White cedar.*

CC. Spray four sided. *Red cedar.*

BBB. Leaves alternate, scattered along the stem.

C. Winter buds covered with resin, looking as if varnish had been brushed over them. Leaves flat. *Fir.*

CC. Winter buds not resinous.

D. Leaves four sided. *Spruce.*

DD. Leaves flat.

E. Whitish beneath, short, flat, blunt. *Hemlock.*

EE. Leaves lighter green underneath, longer, pointed. A low shrub. *Yew or Ground Hemlock.*

THE LARCH OR TAMARACK.

The larches are most graceful and beautiful trees, forming slender pyramids often 100 feet in height. Our native species in New York State loves the high, cold swamps, and may be found in quantities about the margins of our Adirondack lakes. It has many, long, tough, fibrous roots which especially fit it for life in swampy ground. The larch spray is exceedingly beautiful, as the leaves are attached in whorls to little knobs along the side of a branch. In the European larch, which is commonly planted as an ornamental tree, there may be forty or fifty of the needle-like leaves attached to each one of these knobs, which is really a twig shortened to about one-eighth of an inch; the spray thus has a tufted appearance, each long, terminal twig looking as if it were decorated with fluffy tassels. In the autumn the leaves turn a dull "old-gold" and fall to the ground, which is a very unusual performance on the part of the leaves of a cone-bearing tree.

LESSON ON THE LARCH OR TAMARACK.

14. Describe or figure the cones, giving size, color and shape.
15. Do they grow at the tip or along the sides of the branches?
16. Do they stand up or hang down?
17. What is the special value of the tamarack wood?
18. Why is it used for water pipes?
19. What does Longfellow say about the larch in Hiawatha?
20. If you have ever been in a tamarack swamp, describe it.

PINES.

Among all of our tree friends the pines are the most companionable, for they are the only ones which habitually condescend to conversation. I have several friends among the pines, and each has its own tone of voice and tells a different story; and one rarely speaks at all. Aside from being friendly trees, the pines are most interesting as subjects of study. The arrangement of their tasseled leaves, and their mathematically tessellated cones, their whorled branches and their mighty roots spreading far on each side, afford inviting subjects for study. If we live in a land where stump fences abound then we have excellent opportunities for studying the great underground system of these splendid trees. The pines require at least two seasons for maturing their cones, differing in this respect from the other evergreens.

We have common in almost every locality in New York State two species of pine, the white and the pitch-pine. Here and there in the forests occurs the red pine; and on the sandy soils of Long Island occurs the Jersey scrub-pine. Besides these we have two European species, which are commonly planted as ornamental trees; these are the Austrian and the Scotch pines. The following table will assist you in determining which species you have at hand:

THREE NATIVE PINES COMMON IN NEW YORK STATE.

A. Leaves five in a bundle. *White pine.*

AA. Leaves two, rarely three in a bundle.

B. Leaves slender, 4-6 inches long. Cones at or near the tips of the branches. *Red pine.*

BB. Leaves stout and stiff $1\frac{1}{2}$–$2\frac{1}{2}$ inches long. Cones borne on the sides of the branches. *Jersey scrub-pine.*

AAA. Leaves three in a bundle. *Pitch-pine.*

TWO PINES COMMONLY PLANTED IN PARKS AND GROUNDS.

A. Leaves two in a bundle, 4–6 inches long, dark green and very stiff. *Austrian pine.*

B. Leaves two in a bundle $1\frac{1}{2}$–$2\frac{1}{2}$ inches long, grayish-green, broad and flat, soft and flexible. *Scotch pine.*

The White pine.—This is the most graceful and beautiful of our pine trees. Its long, fine, grayish-green tassels make most attractive foliage. Its long cones differ greatly from the cones of the other pines of this region in that the cone scales are thin towards the end, while in most of the others the cone scales are much thickened at the tips.

The Pitch-pine.—This is also quite a common tree. It is coarser; its foliage is shorter and more bushy; it is never so beautiful or so graceful as the white pine. It is a hardy tree and will grow on rocky and sterile soil. It is the only pine that sends forth shoots after it has been injured by fire.

The Jersey scrub-pine.—This is a short tree rarely growing higher than thirty or forty feet. It has long branches, and is in shape a broad pyramid. It seems to grow in the most sterile soils, and is found on worn-out lands as well as upon the sandy soils of Long Island.

The Red pine.—This is sometimes called Norway or Canadian pine. It usually grows 80 feet in height and has a beautiful, straight trunk, which is salmon-colored where the thin bark has scaled off. The foliage of the tree as a whole is not so dense as in the white pine, but the needles are larger and longer. It is sometimes, but too rarely planted in parks.

The Austrian pine.—The very long, stiff leaves form its chief characteristic. It is a handsome tree, and much resembles our native red pine, except that its leaves are more pointed and much less flexible, and also larger in diameter. It is hardy in this climate, and since it is so generally planted in parks and grounds it affords a fine opportunity for the study of the flowers and the pollination which occurs the last of May or early June. It is a native of the mountains of eastern Europe, and there often reaches the height of 120 feet.

The Scotch pine.—This pine so commonly planted has such flat, short leaves that it has been miscalled Scotch fir, and many people know it under that name. Its leaves scarcely ever exceed two inches in length and many of them are not more than an inch long, and are broad, flat and flexible. It is one of the most important of the timber trees of Europe and Asia. However, here in America it is not so successful, and rarely lives a half century.

LESSON ON ANY PINE IN YOUR LOCALITY.

21. What is the general shape of the tree, and where does it grow?
22. What is the shape of the cone?
23. What is the character of its bark?
24. How long are the needles, and how do they compare in length and thickness with any other species of pine in your locality?
25. How many needles grow together in a bundle?
26. Is this bundle enclosed in a little sheath at the base? (In the white pine the sheath drops off very soon.)
27. Are these bundles grouped in distinct tassels; if so, how many constitute a tassel?
28. What shade of green is the general color of the foliage?
29. Cut a pine needle in two and look at the end with a lens, and note its shape. The white pine differs decidedly from the others in this particular.
30. How can you tell this year's from last year's and from next year's cones?
31. How old is the cone when it opens and scatters its seed?
32. How many seeds are there under a single cone scale?
33. How many kinds of flowers does the pine tree have and where are they borne?
34. How is the pollen carried?
35. What is the most important, commercially, of our pine trees?
36. What is the pine wood used for?
37. What is resin? Of what use is it to the tree? To the cone?
38. What is the difference between resin and rosin?

THE CEDARS.

We have two cedars common in New York State, the red and the white.

Arbor vitæ often called white cedar.—This is a common hedge tree, and its flat foliage is very beautiful when examined carefully through a lens. It looks as if had been pressed with a flatiron. The arbor vitæ grows in wet places, as well as along streams, where it makes almost impenetrable forests. In the Adirondacks it grows at an altitude of 3,500 feet. The southern white cedar may be distinguished from the arbor vitæ by the fact that the tips of its branches are not more than 1-16 inch in width, and that its cone is a little knobbed ball.

LESSON ON THE ARBOR VITÆ.

39. Take a twig, remove the leaves and describe their relation to the twig.
40. Draw a bit of the spray showing the shape and arrangement of the leaves. Use a lens for this.
41. Are you acquainted with the arbor vitæ as a separate tree in hedges?
42. How many scales are there in the cones and where are the seeds borne?
43. What is there about the foliage and the way it grows that fit it for a hedge plant?

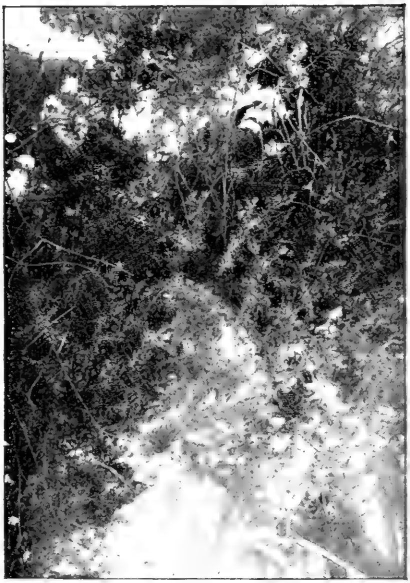
The red cedar.—The twigs of this and their surrounding leaves have not been flattened as in the arbor vitæ, but each little twig looks like a braid of green yarn. There are two kinds of leaves on the red cedar, the green leaves which overlap each other, and which are seen at first glance, and some other pointed needle-shaped leaves not overlapping, which are often brownish and are not so readily seen, but which you feel if you put your hand against the foliage. The fruit of the red cedar is a bluish berry.

44. Describe the foliage of the red cedar giving the shape of the green leaves, as well as the sharply pointed ones.
45. Is the spray of the leaf four-sided or cylindrical?
46. Describe the fruit carefully, giving its color and form.
47. How many seeds are there in each fruit?
48. What is the wood of the red cedar especially used for?

BALSAM FIR.

This is the only native fir tree common in New York State, though the silver fir of Europe is planted more or less in our parks. Whoever has been fortunate enough to have been in camp in the North Woods, and has reposed upon a bed made from the fragrant branches of this tree has something delightful to remember. And those who have not used the branches for a bed may have laid their heads upon pillows filled with the dried leaves of this beneficent and health-giving tree. The balsam fir is often planted as a shade tree, and is likely to be found in the yards of farm houses, rising a black and graceful spire far above the house top. This fir may be distinguished from the spruces by the leaves, which are flat and thin, and very blunt at

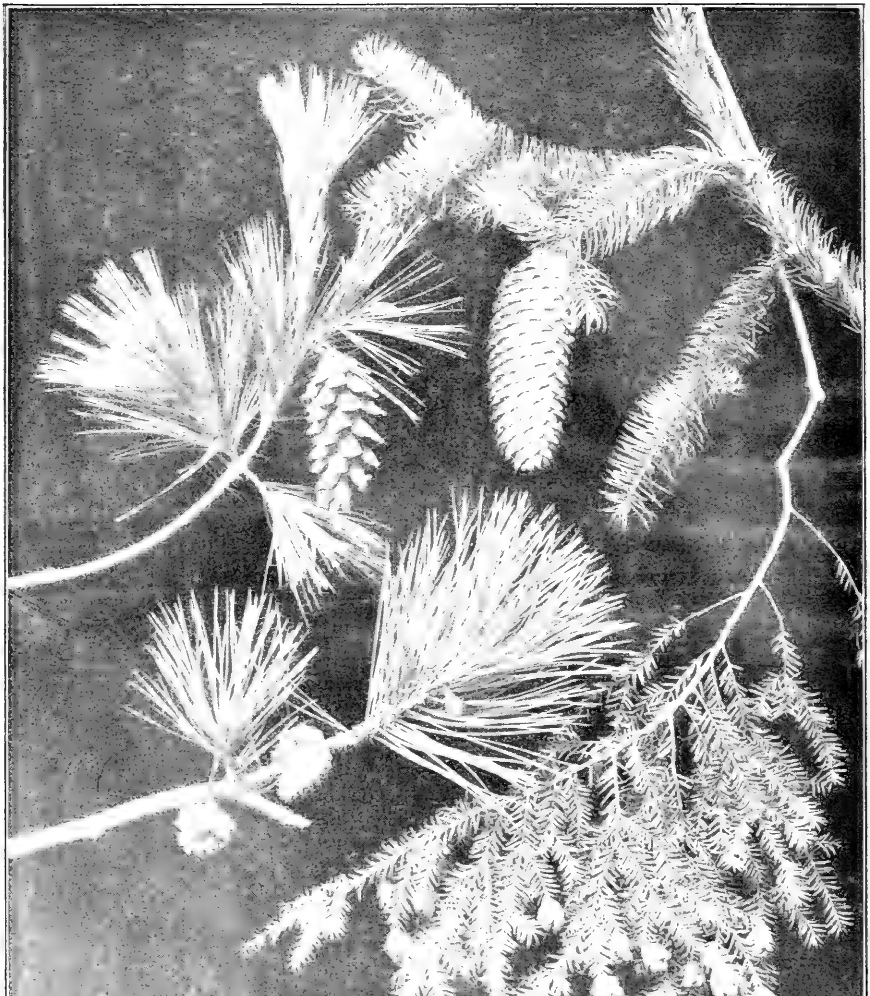
Arbor vitæ.



Ground hemlock growing against a bank.

Larch in winter.

Pitch pine.



the tip, and by the fact that the winter buds are protected by a coat of resin, which makes them look as if they were varnished.

49. If you know the balsam fir, describe it?

50. Where does Canada balsam, the clear gum in which we mount microscopic objects, come from?

51. How does it occur on the tree?

52. How are the leaves arranged on the twigs, that is, do they project in all directions?

53. When the tree grows in the open is the bole bare for any distance above the ground?

54. How do the trees grown in the woods differ in this respect from those in the open?

THE SPRUCES.

In the mountains of New York State these most valuable trees are common. There are three species, the white, the black and the red. The black spruce is so-called because its foliage massed against the mountain side looks black, whereas the white spruce is much lighter in color, being grayish-green. The cones of the white spruce are slender and elongated, being often more than twice as long as wide, while those of the black and red species are much thicker in proportion. The red and black species were for a long time considered one, and are regarded so now by lumbermen. However, the botanists consider them distinct. The cones of the red spruce fall during the first winter, while the cones remain upon the black spruce several years, and this is the chief way of distinguishing them. Birch beer is made from both the black and the red spruce, and chewing gum also. The white spruce has a disagreeable odor. The spruces have leaves which are four-sided; in cross section one of these leaves is more diamond-shape than square. The cones hang down instead of standing up.

The Norway spruce is planted everywhere, and may be taken as our type for study. It is common in our parks and planted grounds, and is sometimes used for hedges.

LESSON ON THE NORWAY SPRUCE.

55. What is the shape and length of the leaves?

56. How many lengthwise ridges has each leaf?

57. Are the leaves arranged all around the twigs?

58. How in relation to the twig are the points directed?

59. What is the shape, size and color of the cone?

60. Where on the twig is it borne? Does it hang down or stand up?

61. Figure or describe a seed.

62. In the old trees do the twigs stand out all around the branches or do they hang down?

63. How is this arrangement of the twigs on the branches useful to the tree in its native climate?

64. Do the Norway spruces when standing in the open show any bole below the branches or do the branches grow to the ground?

HEMLOCK.

The hemlock during its youth and middle age is the most graceful and beautiful of all our evergreens, and in its old age it is the most picturesque. There is no prettier sight in all the tree world than a symmetrical, vigorous hemlock, when the new growth of vivid, light green tips every twig, making exquisite contrast to the dark, dull green of the older foliage. And there is no such picture of old age and loneliness as the old hemlock towering above its fellow trees with its upper branches bare and black extending helplessly toward the four winds of heaven. It is a pity that a disease has attacked our hemlocks in New York, and is surely though slowly killing all that are mature. It is as if they were discouraged at the wanton destruction of their species by man and die rather than suffer the ignominy of the ax.

LESSON ON THE HEMLOCK.

65. Describe the tree.
66. Do the branches extend straight out or droop at tips?
67. Describe the foliage.
68. Describe or sketch a hemlock cone.
69. Are the cones borne at the tip or on the side of the branches?
70. Does the cone mature in one season?
71. Describe or sketch the seed.
72. What industry has caused the destruction of the hemlock?
73. For what parts of building construction is it used?
74. What is its special value as building timber?

GROUND HEMLOCK.

This is a low, straggling shrub not more than four or five feet high, which has foliage resembling that of the hemlock, except that the leaves are longer and bright green on both sides. However it is not a hemlock at all, but a yew, and its fruit is a red berry.

LESSON ON GROUND HEMLOCK.

75. In what direction do the branches extend?
76. Is there a main stem?
77. Is the berry edible?
78. How is the seed distributed?

Correlation on the Study of Evergreens With Other Studies.

With history.—In glancing across the wood-covered hills of New York State one often sees stretching far above the other trees the gaunt top of an old, white pine. Such pine trees belong to the forests primeval, and may have attained the age of two centuries or more; they stand there looking out over the world, relics of another age when America belonged to the red men, and the bear and the panther played or fought beneath them. The cedars live longer even than do the pines, often reaching the age of three hundred years.

Perhaps nothing so naturally turns the attention of the pupil to past events than the thought that the life of such a tree has spanned so much of human history. If you have one of these old trees in your vicinity make its life-history the center of a story of local history; let the pupils find when the town was first settled by whites, and where they came from; what Indian tribes roamed the woods before that, and what animals were common in the forests then. Bring out the chief events in the history of the county and township; when were they established and for whom or what were they named. What are the industries of the present village or township, and are they the same as they were a hundred years ago.

With geography.—Where are the cone-bearing trees most numerous? To what climates and soils are they best adapted? Why? (Roth, pp. 32–40.) Where are the forests of cone-bearing trees found in America? (Roth, p. 211.) How is the pine used to reclaim the seashore in France? (Roth, p. 198.) Is there a difference in the species of conifers that live in Florida, and those of the Rocky Mountains and northern Michigan? (Roth, pp. 154–158.)

With industrial geography.—What is the difference between hard and soft woods and what are their uses? In building a house which of the evergreens are used for the timber and which for the floors and finishing, and where do they come from? Describe how and where the following industries are carried on: Lumbering, Wood pulp, Resin and Turpentine; Tar making; Use of tan bark. Why is lumber so high priced at present?

With arithmetic.—One branch of Austrian, pitch or white pine will be of as much use in teaching addition, subtraction, multiplication and division in the elementary grades as any apparatus ever devised by ingenious educators. In fact these leaves are grouped in 2's, 3's and 5's as if specially arranged for an arithmetic class. The cone also affords opportunities for counting and multiplying. If there are two seeds beneath each scale, how many are there in the entire cone, etc.? The cone itself when closed invites to higher mathematics, though I doubt if one trained in conic sections in college would be able to work out the mathematical relations of the scales to the cone.

For the older classes the measuring of trees affords a practical and delightful exercise in geometry. Any boy can construct with a jointed pocket rule an instrument for measuring the height of trees, as described in Roth, p. 171. Calipers for measuring the thickness of trees can also be made by any ingenious boy. After measuring trees let the pupils compute the amount of lumber in each, using the log scale given in Roth, p. 259. This will be a most useful and practical exercise for the older boys and girls.

With English.—Read with your pupils the following poems or such parts as they will understand: *Spirit of the Pine,* by Bayard Taylor; *To a Pine Tree,* by Lowell. The work indicated in industrial geography gives interesting topics for essays.

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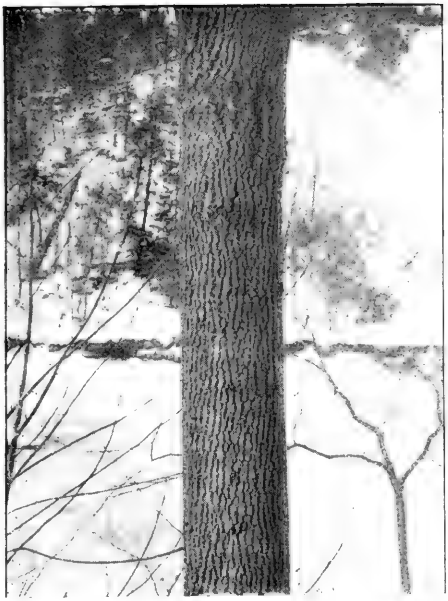
A Guide to the Trees, Lounsberry. (Stokes & Co., $2.50.)
Familiar Trees and their Leaves, Mathews. (Appleton's, $1.75.)
Commercial Geography, Redway. (Scribner's, $1.25.)
Cornell Teachers Leaflet No. 13. Evergreens and How they Shed their Leaves.

A certificate will be granted to those who satisfactorily complete ten lessons or the year's work.

Address all communications to the Editor.



Ash-bark.

Shagbark hickory.

Maple.

Elm.

Common locust.

European white birch.

Red oak.

Lombardy poplar.

HOME NATURE-STUDY COURSE.

TREE STUDY IN WINTER.

It would seem snobbish, to say the least, if we were to recognize our friends and acquaintances only when they were dressed in their best clothes. Yet many of us rejoice in the spreading branches of a tree when covered with leaves, and pass by indifferent when those same branches are displayed in all their grace and beauty of spray shorn of their summer glory. By some the only trees recognized in winter are the evergreens. However, to the true lover of trees they are quite as beautiful and interesting in winter as in summer or autumn, and the characteristics which distinguish them are quite as noticeable.

The country boy who early learns the treasures of the wood-lot recognizes the different species of trees more readily in winter than in summer. It might be difficult for him to say just why he is able to call a tree by name the moment he sees it; he just "naturally knows" what it is. His trained eye takes in at a glance, the general shape of bole and branches, the angle of the branches to the trunk, the coarseness or fineness of the twigs or spray, and, above all, he looks at the bark. Thus it must be with every one who learns to know trees in their winter guise. It is not a knowledge that one can gain from books or from the experience of others; it must be gained at first hand or not at all.

HOW TO LEARN TO DISTINGUISH TREES IN WINTER.

First begin with the trees that grow along the roadsides and in the fields; select the ones you know; then take those you do not know, one at a time; ask the name of any farmer, become perfectly familiar with every detail of its appearance and select others that seem like it. If you are clever at drawing, or even if you are not, try to draw it as a help to observation. Study it according to the following outline:

(a) General shape of whole tree.

(b) Height of bole as compared with height of tree.

(c) Is the bole slender or stocky? Does it continue straight up or divide into great branches?

(d) What sort of bark has it, rough or smooth? If rough, are the ridges or sutures far apart or close together? Do they intersect or are they distinct and vertical? Are there any transverse markings or sutures? If smooth, what is the texture? Does it peel or roll? If so, how?

(e) What is the color of the bark and what blotches are there on it? Are these markings transverse or vertical?

(f) Are the lower branches very large? Does the bark on them resemble that on the trunk?

(g) At what angle do the branches in general stand to the trunk?

(h) Are there many large branches?

(i) Where is the spray borne, along the branches or at the tips?

(j) The spray is a term used for the mass of twigs because they resemble the spray of a fountain. Study the spray; is it coarse or fine? Does it stand erect or droop? What is its color?

(k) A study of buds often helps greatly in case of doubt. What is their color; are they opposite or alternate; are they pointed or blunt; are they large or small when measured by the width of the twig; are they long and slender or nearly globular? Below the bud is a scar where the leaf grew last year. The shape and size of these leaf-scars may determine the species. Are they opposite or alternate? Only three of our common trees have the buds and leaf-scars opposite; these are the maples, the ashes and the horse-chestnuts.

(l) Do the leaves cling to the branches during winter? This is quite characteristic of the beech and certain oaks.

(m) See if there is any fruit or outer shells that contained fruit still clinging to the tree. A dozen of our common trees may thus be identified.

CHARACTERISTICS OF SOME OF OUR COMMON TREES AS SEEN IN WINTER.

The elm is perhaps the most unmistakable of all our trees when leafless. It may be vase shaped, or its branches may droop so that it looks like a flowing fountain, or it may be neither; but there is a "quirly" look about the spray and a blackness of the bark when it has a snow background that reveal its identity.

The maple is another that flaunts its name in our faces; its branches set close, at a sharp angle to the trunk, divide into a fine, erect spray suggesting a giant whisk-broom.

That slender aristocrat from France, the Lombardy poplar, lifts its short branches so that it is always a spire against the sky. And the landscape artist, therefore, plants it where there are buildings with cupolas, turrets and steeples, as it helps give the eye a heavenward lift.

Very different from the Lombardy poplar in its habits of growth is the low, broad thornapple, which spreads itself like a tent in fence corners.

Other lovers of the fence corners are the wild cherries. Of these two are black, one being a true wild cherry, and one being the sweet black cherry, which by the aid of birds has escaped from cultivation to live a happy-go-lucky life in the fields. Both these black cherries may be recognized by the dark, shiny bark. The two may be separated by these characteristics when fully grown: The bark of the wild cherry is peeled off in little curls and appears more ragged, its twigs are slim and drooping instead of erect, and its buds are slender and small instead of nearly globular. The choke cherry and the red wild cherry also flourish in the fence corners. They do not grow so large as the black cherries, and their bark is lighter in color.

The honey locust planted by our forefathers to shelter the homestead holds aloft on its twisted branches the long "polished, mahogany" pods nearly all winter; though some of them the winds tear loose, and they skate over the snow drifts to plant their seeds far from the parent tree. The common or black locust has the same habit and holds fast to its little, rustling pods until late in the season. These pods so dot its upper branches that this tree is easily recognized from the window of a railroad train.

The horse-chestnut planted so generally as an ornamental tree may be distinguished by its sparse, coarse twigs, each ending in a large bud that always calls to mind the knobs formerly placed on the horns of cattle before the era of dehorning.

Some trees love to grow by streams and just the location helps determine them:

The sycamore or button-ball tree is one of these and its trunk and large limbs bearing great blotches of white and dull yellow proclaim its identity from afar.

Quite different in appearance is that other stream lover, the willow, with its great trunk and giant gnarled limbs upholding a confused mass of slender, whip-like terminal twigs. One of the willows has this great bouquet of twigs ochre yellow, and thus brings autumn warmth into the colors of the winter landscape.

The yellow and the red birch also cling to the banks of creeks and rivers. The yellow birch has yellowish-brown bark with silken sheen that breaks off in shabby scrolls. The bark of the red birch is dark and reddish in color and is in rags and tatters, making this tree appear the beggar in the forest world.

Three other birches are found in our woodlands. The black sweet birch can be identified by its glossy, dark bark which looks somewhat like that of the black cherry, and by the wintergreen flavor of the bark on its twigs. The canoe or white birch grows to be a large tree, and is known by its gleaming white bark which is parchment-like when peeled, and covers other pale tan-colored layers, which are used for writing. The gray birch also has white bark, but need not be confused with the canoe birch, as it is a shivery little tree, and huddles together with its fellows on poor, rocky, or sandy soils, each branch having a dark triangular blotch below its base. The white birch of Europe is commonly planted in our yards and parks, its white, rather stiff trunk and branches almost hidden by its purplish gracefully drooping spray.

The poplars resemble the birches in a general way in color of bark, but they are far more tidy, and will never be confused with them even by the casual observer.

The beech is sometimes mistaken for the birch by people who do not see what they look at. The two are not in the least alike; the soft gray bark of the beech may bear transverse blotches of white, but it is not satiny in texture; it is dull and soft like "undressed kid," and fits as close as a glove on the hand of a well-dressed person. This glove-like quality is also characteristic of the soft maples, though their bark is quite different in color and general appearance from that of the beech.

The ashes may be recognized by their beautiful bark which lies in close, even, vertical ridges, making the trunk look as if it had been shaded with lengthwise strokes of the pencil. The spray of the ash tree is coarse and has a blunt look, and the leaf buds are opposite.

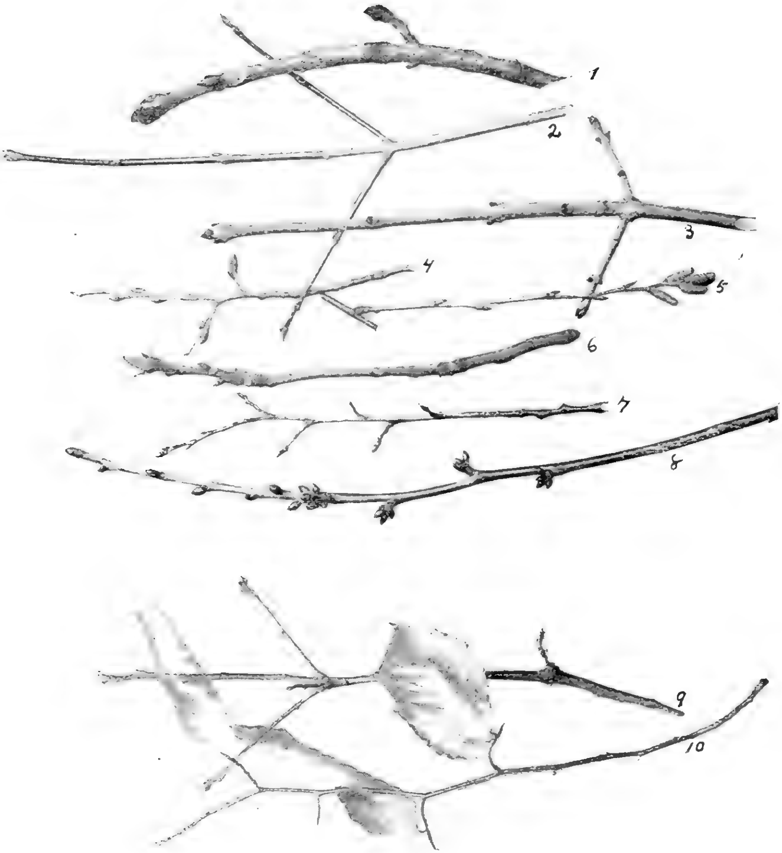
The oaks are characterized by their gnarled and rugged branches, which leave the trunk at a wider angle than is the case with most species of deciduous trees. There is a staunch and burly look to the oaks that reveals their powers of endurance.

The hickories have much the same sturdy character as the oaks, but usually they are more slender in outline. The shagbark hickory which is more nearly like the oaks in form than the others may be easily identified by the rough, loose bark, which gives the appearance of shiftlessness to an otherwise handsome tree.

Thus does each tree species reveal its identity, though it be leafless. The limits of this leaflet forbids the characterization of more kinds, but it is hoped that each pupil in the Home Nature-Study class will

Some trees may be identified by the fruit which remains during winter. Name these fruits.

What trees were these thorny twigs taken from?



Trees may be recognized by the form and arrangement of their buds.

1 *Horse-chestnut*
2 *Sugar maple*
3 *Ash*
4 *Elm*
5 *Yellow birch*
6 *Shagbark hickory*
7 *Wild black cherry*
8 *Sweet black cherry*
9 *White oak*
10 *Beech*

begin and continue this study. The study of trees, like the study of birds, cannot be finished in one year nor ten,—but when once begun is carried on involuntarily and unconsciously, thus adding delightful and ever-growing interests to take us afield.

LESSON ON TREES IN WINTER.

1. What is happening in the life of the tree in the winter?
2. Where is the sap? Why do not the trees freeze and burst?
3. Where are the leaves for the coming year? Why do you think so?
4. How can you tell where last season's leaves were?
5. How many species of trees are you able to distinguish when leafless? What are they?
6. There are at least eight common trees that may be distinguished at a glance at the bark; what are they?
7. Look at figure of fruits that cling all winter, and tell what they are. Do you know any others that may be thus distinguished?
8. Look at the figure of three thorny branches below; tell what trees these belong to.
9. What birds' nests are seen in the winter in elms; in maples?
10. Select two trees and describe each according to the method suggested on the first pages of this lesson.

THE COW.

The history of the development of the different breeds of cows is interwoven with the history of the civilization of different peoples. Our neat-cattle have been developed from the wild cattle of Europe and Asia, each country developing and breeding them according to its own standards. Thus, England has produced the Short-horns or Durhams, Herefords, Devons, Sussex; Scotland has given us the Aberdeen Angus, Galloways and Ayrshires. The islands of the English Channel have developed the Guernseys, Alderneys and Jerseys. Holland and Denmark produced the Holstein-Friesians and Dutch-belted, Switzerland, the Brown Swiss, and France, the Norman breed. In looking over the map of Europe we are impressed by the fact that all the best breeds of cattle found in the world to-day were developed in the British Isles, and Europe north of Italy and east of Russia.

Man from the first found horned cattle especially useful in two ways: they yielded him flesh and milk for food. So he developed two strains, beef cattle and milch kine, the types of each differing so widely in appearance that they seem almost like different species.

The beef animal is in cross section approximately square, being big and full across the loins and back, the shoulders and hips covered heavily with flesh; the legs stout; the neck thick and short and the face short. The line of the back is straight and the stomach line parallel with it. Very different is the appearance of the milch cow. Her body is oval instead of being approximately square in cross section. The outline of her back is not straight, but sags in front of the hips, which are prominent and bony. The shoulders have little flesh on them, and if looked at from above, her body is also wedge-shaped, widening from shoulders backward. The stomach line is not parallel with the back bone, but slants downward from shoulders to the udder. The following are the points that indicate a good milch cow: Head wide between the eyes, showing large air passages and indicating strong lungs. Eyes clear, large and placid, indicating good disposition. Mouth large, with a muscular lower jaw showing ability to chew efficiently and rapidly, and the neck should be thin and fine, showing veins through the skin. Chest deep and wide, showing plenty of room for heart and lungs. The abdomen should be large but well supported and increase in size toward the rear. The ribs should be well spread, not meeting the spine like the peak to a roof, and the spine must be prominent, revealing to the touch separate vertebræ. The hips should be much broader than the shoulders. The udder should be large, the four quarters of equal size and should not be fat. The "milk veins" which carry the blood from the udder should be large and crooked, passing into the abdomen through large openings. The skin of the cow should be soft and pliable and covered with fine, oily hair, showing good digestion and assimilation. Above all the milch cow should be always hungry, for she is a milk-making machine, and the more fuel (food) she can use, the greater her production.

The physiological habits of the beef and milch cattle have been changed as much as their structure. The food given to the beef cow goes to make flesh; while that given to the milch cow goes to make milk, and she will not put on flesh while giving milk, however abundant her food. Of course, there are all grades between the beef and the milch types, for many farmers use their herds for both. However, if a farmer is producing milk it pays him well to get the best possible machine to make it, and that is always a cow of the right type.

America has no wild cattle except the buffalo, and they have never been domesticated, so we have brought the different breeds from Europe. Cattle have played a most important part in our civilization and wealth. In pioneer days the patient oxen were our chief means of transportation and of clearing land. In many of our Southern States to-day a common sight is two or three ox teams carrying heavy loads over rutty or sandy roads. I have always thought that a handsome pair of well-broken oxen were a delightful team to ride after.

At present the beef breeds of cattle are grown more in the West, where they have taken the place of the buffalo herds on the great plains; while the milch breeds are of greater importance in the East and Middle West.

In New York State the dairy cow is seen almost everywhere, and the dairy industry is being revolutionized at the present time. The teacher of every village and rural school can aid greatly in this revolution by educating the children to higher standards and better methods of milk production and preparation. In the best dairies the following methods are followed:

The herd is improved constantly by keeping a thoroughbred sire at the head of it.

The stables are cleaned thoroughly every day, the sweeping of the floor being a part of the daily routine. The milkers brush the cow's udder and wash their own hands before milking.

The milk is not strained in the barn where the odor of the stable will affect it, but is strained in the open air or in a room prepared purposely for it.

A pair of scales stands near the can for receiving the milk and as the milk from each cow is brought in it is weighed and the amount set down opposite the cow's name, on a "milk sheet" that is tacked up on the wall near by.

At the end of each week the figures on the milk sheet are added, and the farmer knows just how much milk each cow is giving him and whether there are any in the herd which are not paying their board. While to the old-fashioned farmer weighing each cow's milk seems "fussy," yet it takes little time and removes guesswork from the dairying business. The up-to-date farmer likes to know where he stands. Besides the care of the stables and milk a well-balanced ration of food is given to the cows, and plenty of fresh, good water provided for them, and they are kept in warm stables in the winter, thus saving much fodder and grain. I know a dairy in New York State which under ignorant management produced only 3000 pounds of milk per cow during the year; the next year the same dairy, properly fed and housed, yielded 6000 pounds of milk per cow. Good care of the dairy cow often measures the difference between profitable and unprofitable farming.

LESSON ON CATTLE.

When we take the subject of cattle for Nature-Study we naturally follow two lines of inquiry, one regarding the natural history of the animals, and the other dealing with their domestic history and use. First we will study how they live in a wild state, and how they are adapted in form to such conditions.

1. Do wild cattle live in herds or singly?
2. What are their enemies?
3. How does the herd defend itself from enemies?
4. In herds of buffalo or wild cattle where are the calves, the cows and the bulls when attacked?
5. How does the individual defend itself?
6. Are the great heads and shoulders of the bulls developed for fighting enemies or each other?
7. What is the food of wild cattle and where do they find it?
8. How are the teeth arranged to get their food?
9. What is the process of chewing the cud?
10. Can you think of any advantage to wild cattle that comes from the cud-chewing habit?
11. Compare a cow's legs and feet to the legs and arms of man, and tell what part corresponds to the elbow, wrist, knee, ankle, heel, toes. What part does the cow walk on?
12. In a natural state cattle frequent shallow rivers and marshes in order to get water. Can you think of any advantage which the split hoof gives them in such situations?
13. How are the cow's feet and legs placed when she lies down to sleep?
14. How does she get up and down? Compare in this respect with a horse.
15. When a calf is born in the fields it is often hidden by the cow and will refuse to stir when discovered. What is the origin of the habit?
16. Name and give brief descriptions of all the different breeds of cattle with which you are familiar.
17. Which of these are beef and which are milk producing? Is the cow pictured at the head of this lesson of the beef or milk type?
18. What are the distinguishing points of a good milk cow?
19. How many pounds of milk per year should a dairy cow give to be profitable if the product is cheese? If the product is butter? Why this discrepancy?
20. What is the per cent of butter-fat in milk necessary to make it legally salable in New York State?
21. How many months of the year should a good cow give milk?
22. Why and where is dehorning cattle practiced?
23. When and how should a calf be dehorned?
24. Should a dog be used in driving dairy cows? If not, why?
25. Why should a cow be milked during the season by the same person?
26. Why should loud talking and noise during milking time be avoided?
27. Why is a cold barn which allows wind to enter, a means of extravagance in fodder and grain?
28. Why should milk not be strained in the barn?
29. Why is it profitable for the dairy farmer to keep his stables clean and be cleanly in the care of the milk?

CORRELATION OF NATURE-STUDY WITH OTHER STUDIES.

Geography.—The children of your school are undoubtedly familiar with some distinct breeds of cattle, especially if they have attended the agricultural fairs. Study in every possible way the lives and habits of the people in the countries in which these breeds were developed. Geography readers will aid much in this respect, and our common cattle will be a direct means of interesting the children in Holland, Denmark, the Channel Islands, and the different countries of England and Scotland. The relation of people to cattle in different countries will also prove interesting. Let pupils read how cows are used for plowing and burdens instead of for milk in China; and how the people of India have sacred cattle, and how the peasants of Germany often live on the second floor of the house, the first floor being the stable of cows which are kept most clean; and how the milk peddlers of Cuba and other hot countries sometimes drive the cow from door to door, always taking the calf along to start the flow of milk. The geography of our own country should be studied also to discover the reasons why beef cattle are raised in the far West and dairy cattle in the Middle West and East. In fact the enterprising teacher will find that the cow path leads over all the world, and that her pupils will take great pleasure in following it.

Industrial Geography.—There is to-day very little waste from the carcasses of cattle; and aside from the dairy, beef and tallow industries there are connected with the cattle business the manufactures of leather, plaster, glue, buttons, fertilizers and many others. The pupils should study each of these industries. Also let them note that the countries which produce great amounts of hides and tallow are not dairy countries.

Language Work.—The well-marked breeds like the Jerseys, Ayrshires or Holsteins afford excellent subjects for simple descriptions, which should include size, color and the striking characteristics. Advanced work may be done in connection with the geography work, giving the results in interesting form. How and why the pioneers used oxen for transportation and logging would be an excellent theme. The story of pet calves and cows would be an interesting subject for the country child to write about. The Mowgli story "Tiger Tiger" in the "First Jungle Book" might be read and the actions of the buffaloes described in an essay.

Drawing.—Send a stamp for a blank application for registry to the Secretary of the Guernsey or Holstein Breeders' Association. Let each pupil make a copy of the outline and fill it out with the color and markings of the Guernsey or Holstein cow in the neighborhood.

Much is said of the beauty of the horse, but rarely is allusion made to the beauty of the horned cattle; this is unfair, for a fine cow or ox is truly beautiful. The soft yellow skin beneath the sleek coat of hair, the well-proportioned body, the mild face crowned with spreading polished horns and illuminated by the large, gentle eyes, are all elements of beauty which artists have recognized, especially the great artists of the Dutch school. The ancients also admired the bovine eyes, and their most beautiful goddess they called "The Ox-eyed Juno."

Invest 25 cents in Perry or Cosmos pictures of the paintings of cattle by Paul Potter, Van Marcke, Bonheur, Dupre and Tryon, so that the pupils can see artistic reproductions of cattle. Let the pupils sketch calves and cows; even if the attempt is crude it will serve to stimulate observation.

A certificate will be granted to those who satisfactorily complete 10 *lessons, or the year's work.*

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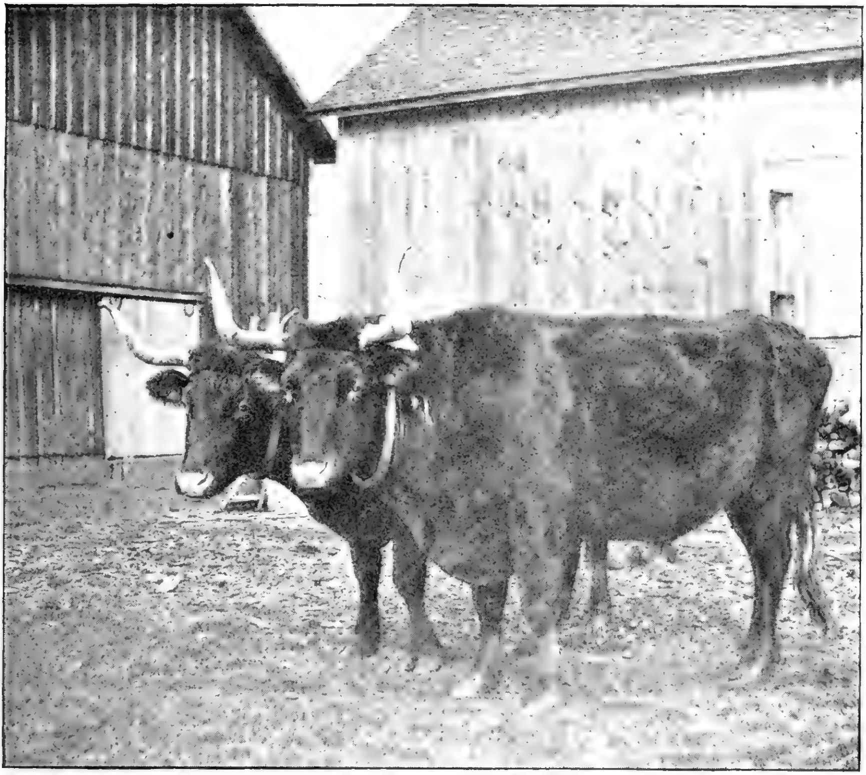


A handsome pair of well-broken oxen.

A dairy cow of perfect form.

Photograph by Verne Morton.

How do chickens get their food?

Photograph by Verne Morton.

Who sees a partridge?

HOME NATURE-STUDY COURSE.

BIRD STUDY.

Bird study is of the utmost importance from every point of view. First, birds are of the greatest economic importance and whoever owns a farm, garden or orchard must learn to know the birds and to deal with them intelligently, if he would reap from his possessions the highest possible financial returns. Second, birds are most interesting and delightful creatures to study, as they have attained a degree of development in their habits, especially as to migration and nest building, which seems to us little short of the miraculous. Third, many of them are exquisite in color, graceful in form and their songs delight the ear and cheer the spirit. It is, therefore, a great addition to the interest and pleasure gained from walks in the fields and woods, if we know by sight and song a number of these little friends in feathers.

One of the ideals to be attained by the teacher of nature-study is to cultivate the child's interest in the life of the world at large by studying at first what is most familiar in his every-day life. The first nature-study lesson, beginning at the point of the child's greatest interest, should be like a pebble dropped in the pond and create wider and ever widening waves of interest. For this reason the greater the interest and pleasure of the first lessons the wider the results; therefore, birds which so charm even the youngest child offer a most felicitous introduction to the study of nature's ways.

One of the mistakes often made in beginning the study of birds with small children, is in placing stress upon learning by sight and name as many species of birds as possible. The young child is more interested in what a bird does and how it does it than in knowing the names of many birds. To start a child in bird study and teach him that the bird is especially fitted for its life and that its form is determined by what it does, there is no better subjects for study than the chicken and the duckling or gosling. These are close at hand and may be studied in the home or in the schoolroom; and by beginning thus and learning about the form and habits of these interesting domestic birds, the child gets an understanding of the needs and of the lives of other birds.

For the following lesson, a chick should be studied by the pupils, letting them answer the questions after they have had time to observe. The ideal way for conducting this lesson would be to have a chick in a box in the schoolroom so that the pupils might see it during recess, the lines of their observation being directed by the teacher's questions. A chick a day or two old is best, and it should be kept three or four days in the room.

To be sure that the members of the Home Nature-Study class know all that the chicken may teach in beginning bird study, I will ask you to make the following observations:

1. Where did the chick come from? What is the shape of an egg? Which end of the egg did the chick break through? Does the chick ever come out of the egg head down?

2. Of the inner parts of the egg there are two, the white and the yolk. What is the use of each in developing the chicken?

3. In a hard-boiled egg there is a cavity at one end. Which end? Why is this cavity? What does it do for the chick?

4. How long was the egg in the incubator or under the hen before it hatched? Why will eggs hatch in an incubator as well as under a hen?

5. Did the chick get out of the egg by its own exertion or did the hen assist it?

6. Look at the bill of a chick less than a week old, and note the little tooth on the tip of the upper part of the beak? What is this for? Is it present on older chickens?

7. What is the color of the chick above and below? What markings has it? Can you tell by the color of the chick what will be its color when it is grown?

8. What is the chick covered with? How does this covering differ from that of the hen?

9. Why should the chick just out of the egg be so pretty and downy, while the young robin just hatched is so bare and ugly?

10. How does the young chick get its food? How does the young robin get its food?

11. Describe the eye of the chick; can it see straight ahead as we do? Why does it turn its head to one side and then the other when it looks at you?

12. Why should the young chick be able to see and the young robin be blind?

13. What does the chick eat and where does it get its food?

14. Describe the beak and tell how it is adapted to secure the food?

15. Does the chick chew its food before swallowing it? Why?

16. How does the chick drink? Why does it drink this way?

17. Where are the chick's ears? Does it learn readily certain sounds so that it comes to its food when you call?

18. What sounds does the old hen make which the chickens obey?

19. Can the chicken smell? What makes you think so?

20. Can you see the beginning of the comb? What is the comb for?

21. Describe the chicken's foot and leg. Describe the toes. Which is the longest? Make a picture of a chicken's track.

22. Sketch a bit of the chick's leg showing the arrangement of the scales. What are these scales for? What are the chick's feet used for beside to walk on? Does the chick or hen walk, hop or waddle when it goes rapidly?

23. Do the chicken's feet correspond to our feet or to our hands? What part of the chicken's anatomy corresponds to our arms and hands?

24. Can the little chick fly? Has it any wings? Does it need to fly to get its food? Would the young robin if it had no parents need to fly to get its food?

25. Why can the hen fly better than the chick?

26. Can the hen fly like the robin or the crow?

27. How far can a hen fly? Why can she not fly farther? Why does she need to fly at all? Compare the size of the hen's wings with her body, and the size of the robin's wings with its body, to answer this question.

28. Has the young chick any tail? Will it ever have any? Why does the young chick not need a tail? What use is the tail to a grown fowl?

29. Where does the chick sleep at night? Where will it sleep when it is grown up?

30. Where will it put its head while sleeping after it is grown up? Why does it not do that now?

31. Did you ever see a partridge? Compare the partridge with a domestic fowl in order to understand how the latter might live in a wild state.

32. How does the young partridge escape when enemies are around? Where does the partridge stay in the winter? On what does it live? Where do our hens stay in the winter? If the partridge does not need to go south in winter, why not? If it did need to go south, how would it get there?

33. Does the chick try to preen its feathers? If so, how?

34. What noises does the chick make? Does it open its beak when it peeps? How many emotions does the chicken express through its voice?

35. *A lesson in bird language:*

The fowls are among the most accomplished linguists of the bird world, even though they have little fame as musicians. However, I have always held that the song of the hen when she strolls about on a bit of bare ground during a sunny day of early spring is as happy a sound as can be found anywhere in nature. The study of the language of the chicken yard is good training to the ear and leads to an understanding of bird talk. The hen and the rooster express by voice at least ten different mental conditions or emotions with perfect distinctness. What are these and how are they expressed?

STUDY OF A DUCKLING.

Last summer I had the interesting experience of caring for a time for some incubator-hatched ducklings; and for those who assert that the mother bird teaches the young nothing, I would advise the study of incubator orphans. In early years I had cared for ducklings which were brought up by a hen, an obviously well meaning but ill adapted step-mother. But even the ducklings mothered by a hen were so far in advance in intelligence of the poor institutionized creatures of the incubator, that I have begun to have thoughts about a society for the prevention of incubators, or for the establishment of asylums for idiot ducklings hatched in them.

The lesson on the duckling should follow that on the chick in school, and should be conducted in a similar manner.

36. Compare the covering of the duckling with that of the chick. Compare the bill of the duckling with that of the chick. Why the difference? How is the bill of the duckling fitted for getting its food? What is its food now? When grown up?

37. Describe the duckling as it swallows its food. How does its body act while it is swallowing?

38. How does the duckling get the water in its beak? Does it hold its head up like the chick when drinking?

39. Describe the duckling's foot. How many toes has it? Between what toes does the web extend? What is the web for?

40. Describe the legs of the duckling. Are they longer or shorter than the chick's? Are they nearer together or farther apart than the chick's? Are they farther back than the chick's?

41. Explain the reason for this different form and arrangement of the duckling's legs. Which walks and runs the better, the hen or the duck?

42. Though the duckling's habits of eating are very untidy and it is almost impossible to keep the water pan clean, yet the ducklings are fastidious and take excellent care of themselves. Note the following points in the way a duckling makes its toilet: How does it clean its beak? Its eyes? Its foot? Its back? How does it oil its feathers on its head?

43. Have you seen a duckling go to sleep in the sunshine? If so, how did it act? Did it yawn? How did its eyes close? Did it stretch its feet bottomside up in the sunshine? If so why?

44. Wherein does the duck's plumage differ from that of the hen? Where does down come from?

45. Compare the sounds made by the duckling with those made by the chick.

46. As the partridge gives some idea of what the life of the chick might be in a wild state, so the wild ducks show us the habits of the duck in a wild state. Where do the wild ducks spend their winters? Where do they breed in the summer? Why cannot most of our domestic ducks fly like the wild ducks? What breeds of our domestic ducks are good flyers?

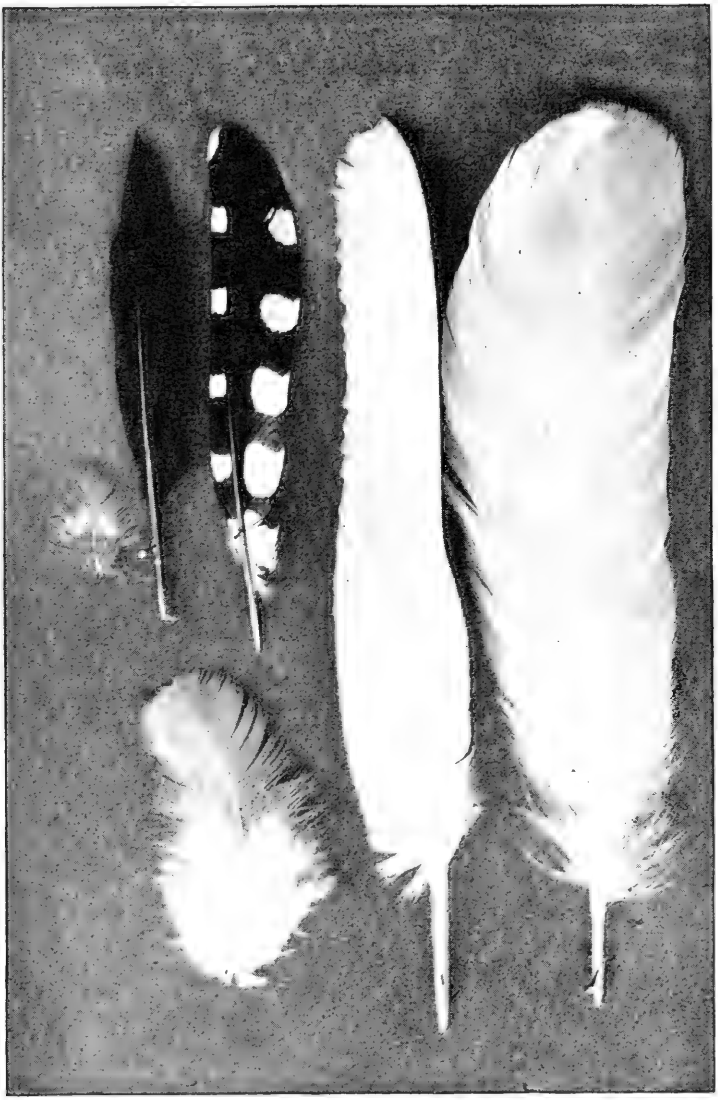
A STUDY OF FEATHERS.

Sometimes old adages are not true, and the one which declares that fine feathers do not always make fine birds is one of these; for fine feathers do certainly make fine birds, and whether the wearer of the feathers can sing delightfully or not has nothing to do with the case. A study of feathers is very necessary to an understanding of the life and actions of the birds. A study of feathers should be given in school, perhaps in the third grade, after the children have become familiar with some birds and the peculiarities of bird life.

For this study, take from the domestic fowl a wing feather, a tail feather and a feather from the breast. There are three parts to a feather; you had best learn these before attempting this lesson.

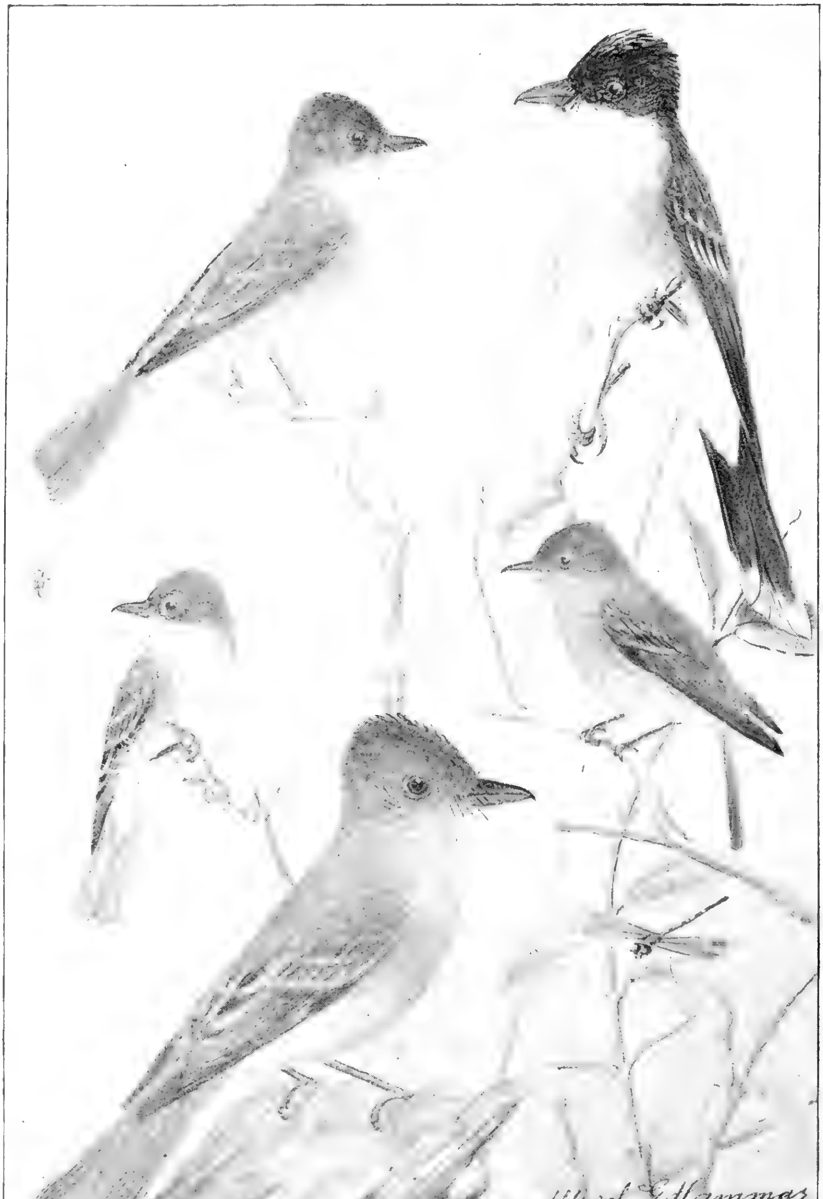
Breast feather.—

47. Describe its shape and appearance? How far do the barbs extend toward the base of the quill? Are the barbs near the base of the feather the same in



Photograph by C. W. Palmer.

Which are wing feathers? Which are tail feathers? Which are breast feathers? From what birds were they taken?



Phœbe
Chebec
Kingbird
Wood Peewee
Great-crested Flycatcher

shape and appearance as those at the tip? Which part of the feather lies underneath?

48. Describe the different uses to the birds of the base and the tip of this feather.

Wing feather.—

49. Are the barbs on one side as long as they are on the other?

50. Which side lies on the outer side and which on the inner side of the wing?

51. Is the quill of the feather curved?

52. Which side is uppermost in the wing, the convex or the concave side? Take a quill in one hand and press the tip against the other. Which way does it bend easiest, toward the convex or the concave side?

53. What had this rigidity or flexibility to do with the flight of the bird? How does the bird lift itself in the air?

54. If the bird flies by pressing the wings against the air on the down stroke, why does it not push itself downward with its wings on the up stroke?

55. What is the shape and arrangement of the feathers so as to avoid pushing the bird back to earth when it lifts its wings?

Tail feather.—

56. Is the quill of the tail feather curved? If so, is the curve like that in the wing feather?

57. Are the barbs on each side of the quill equal in length and similar in arrangement?

58. What is the use of the tail to the bird when flying?

59. What other uses than that of flight has the tail feather in rooster, chimney swift, flycatcher, peacock?

Other questions on feathers.—

60. What is the general difference in color of plumage between the hen and rooster, the turkey gobbler and the turkey hen, the drake and the duck, the male and female oriole?

61. Why is this difference? What is the utility of feather ornamentation?

62. Why should not the female be brightly colored as well as the male?

63. Name all the uses of feathers.

64. What is a pin feather?

65. How does a feather shed water? How does a hen oil her feathers?

A STUDY OF BIRDS' NESTS.

Much interest in bird architecture and much knowledge of bird skill may be derived by studying the birds' nests, which are easily found in winter, after the protecting foliage has gone. Such nests studied carefully may, in many cases, be identified by the use of Mr. Dugmore's admirable book, "Bird Homes."

Let each member of the Nature-Study class find some such nest and describe it according to the following scheme, so that I may be able to identify it:

66. Where you found the nest.
 (*a*) If on the ground, describe locality.
 (*b*) If on a plant, shrub or tree, tell the species if possible.

(*c*) If on a tree, tell whether it was on a branch, in a fork, or hanging by the end of the twigs.

(*d*) How high from the ground, and what was the locality?

(*e*) If on or in a building, how situated?

67. Did the nest have any arrangement to protect it from the rain?

68. Give the size of the nest, the diameter of the inside and the outside; also the depth of the inside.

69. What is the form of the nest? Are its sides flaring or straight? Is the nest shaped like a cup, basket or pocket?

70. What materials compose the outside of the nest and how are they arranged?

71. Of what materials is the lining made, and how are they arranged? If hair or feathers are used, on what creature did they grow?

72. How are the materials of the nest held together,—that is, are they woven, plastered, or held in place by environment?

73. Had the nest anything peculiar about it either in situation, construction or material that would tend to render it invisible to the casual glance?

OUTLINE FOR BIRD OBSERVATION IN THE FIELD.

A note-book should be made ready by preparing each page with the numbers and the words capitalized in the following outline. The part included in parentheses should be committed to memory so as to aid in taking notes. As the bird is observed, the note should be made opposite the appropriate place on the page. The outline given is one which our Nature-Study classes used for several years, and was adapted from the outline given by Florence Merriam in her most useful and admirable book, "Birds of Village and Field."

NAME. DATE.

I. SIZE. (Compared with English Sparrow, Robin, Crow.)

II. COLORS. (Bright; dull.)

III. MARKINGS.

   1. TOP OF HEAD.
   2. BACK.
   3. BREAST.
   4. WINGS.
   5. TAIL.

IV. SHAPE.

   1. BODY. (Long and slender; short and stocky.)
   2. BILL. (Short and stout; long and slender; long and heavy; hooked; curved.)
   3. WINGS. (Short and round; long and slender.)
   4. TAIL. (Forked; notched; square; fan shaped.)

V. MOVEMENTS. (Hop; walk; creep up trees; bob head and wag tail; twitch tail from side to side.)

VI. FLIGHT.

1. FAST. (Direct; abrupt and zigzag; smooth and circling.)
2. SLOW. (Flapping; sailing or soaring; flapping and sailing alternately.)

VII. LOCALITIES FREQUENTED. (Gardens; orchards; roadside fences; meadows; thickets; woods; rivers; lakes and marshes.)

VIII. FOOD AND MANNER OF OBTAINING IT.

IX. SONG.

1. MANNER AND TIME OF SINGING. (From perch; in the air.)
2. CHARACTER OF SONG. (Plaintive; happy; long; short.)
3. CALL NOTES. (Signal; warning; anger; fear; pain; protest.)

LESSON.

74. Describe the robin according to above outline.
75. Describe the English sparrow, both sexes, according to the outline.

HOW TO KNOW THE COMMON BIRDS.

The best way to become acquainted with the birds of a locality is to take up a group of closely allied species and learn to distinguish them; then take another group, and so on until all of the sparrows, all of the blackbirds, all of the thrushes, all of the woodpeckers, etc., of a region are perfectly familiar. After two or three years of study according to this plan, a knowledge of the common species of all the bird families of a locality may be gained.

The family which I have chosen for the Home Nature-Study class beginning bird study this spring is that of the flycatchers. These birds were chosen because four or five species are common almost everywhere in New York State. Their appearance, attitudes and movements are very characteristic and the songs and nests of several are well known; also, the flycatchers are of the greatest economic importance.

THE FLYCATCHERS AND HOW TO IDENTIFY THEM.

The surest way first to identify a flycatcher is to note its method of feeding. It sits on some dead branch, or on a fence, or on a telegraph wire, always in a place free from dead branches and other obstructions. It sits erect, the tail drooped except that it is frequently jerked up or down as if to help the bird keep its balance.

From this open perch the bird flies up into the air after passing insects, perhaps holding itself poised on its rapidly moving wings while it captures the coveted morsel, then returning to the exact spot from whence it flew. The tail of the dog has always been regarded as an organ most eloquent in expressing the emotions of its owner; the tail of a flycatcher is quite as expressive of the mental activities of the bird,—its movements show plainly an alert, nervous attitude; this twitching seems to indicate that its owner is more than ready to swoop up or down to gather in some unlucky insect which comes within its range of vision.

There are nine flycatchers which have been found within the boundaries of New York State. They may be distinguished as follows:

The *kingbird* is almost black above and has its tail tipped with white in a most striking way. This character alone distinguishes it from the other species.

The *phœbe* and the *great-crest* are somewhat similar in color above, and neither *have wing bars which are noticeable.* The great-crest is sulphur yellow on the lower side and when in flight the tail is almost cinnamon brown. It lives in the woods especially along water courses, and takes its place high up on the trees and its song is harsh and startling. The phœbe is not noticeably yellow beneath and haunts lowly places; it has a peculiar manner of twitching the tail, giving it a sidewise movement, which is most characteristic. The well-known song of the phœbe distinguishes it from all the others of the group.

The *olive-sided flycatcher* is about the size of the phœbe, but is more olive brown above and has brownish dark sides and breast. Two tufts of white feathers on either side the tail show during flight. Its song is a loud and constant "pip-pip-ee." It is found in the Catskills and the Adirondacks where fire or man has made clearings in the forests. It is rarely seen elsewhere in New York.

The *wood peewee* and the *least flycatcher* or *chebec* are colored similarly above and *have ivory white wing bars.* The chebec is only about two-thirds as large as the wood peewee and is much more likely to frequent the orchard and trees about the house. The songs of the two described elsewhere are very different and easily distinguishable.

The *alder flycatcher* has brownish or grayish wing bars which distinguish it from the chebec and the green-crested, and its under parts are whitish instead of yellow like the yellow bellied. Its throat is pure white, this being another mark that distinguishes it from the chebec, with which it is likely to be confused. It lives in alder thickets, along streams and in swamps.

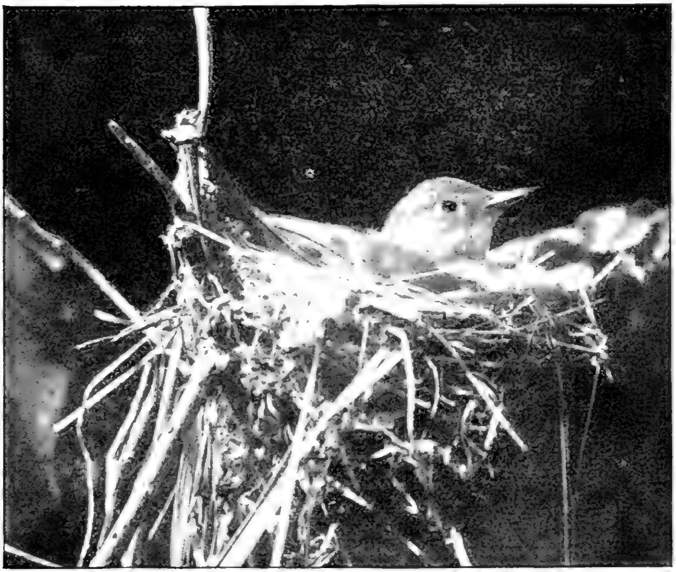
The *Acadian flycatcher* is olive green above with white throat and whitish breast; its wing bars are buff. It occurs in New York only in the southeastern part of the Hudson Valley; its song is "pe-ah-yuk" or "wake-up."

The *yellow bellied* is another small species and is distinguished from the others by having the entire under parts distinctly yellow, shaded with olive on the throat, breast and sides. It occurs only in retired places, having a special liking for low woods and swamps; its song is a short "*pewick,*" it sometimes has a call a little like that of the wood peewee.

Of all the above flycatchers only the kingbird, the phœbe, the wood peewee and the chebec are common in most localities in New York. Next to these the great-crest and the alder are more commonly found.

Photograph by George Fisk.

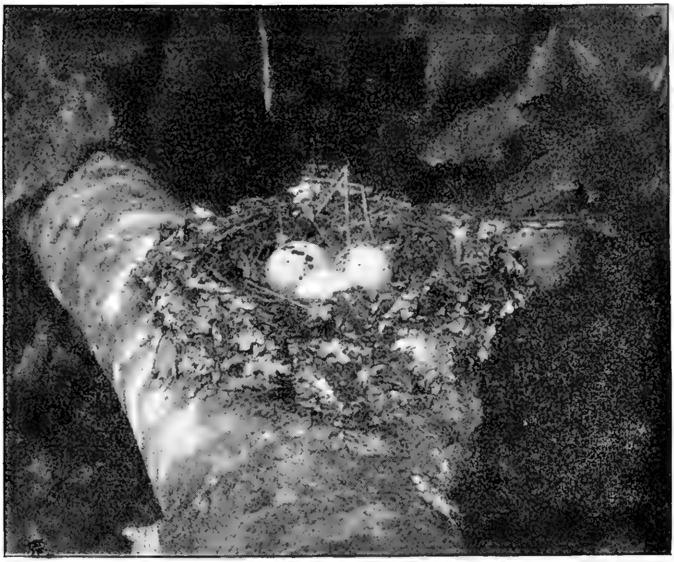
"Go away"—says Mother Kingbird



Photograph by George Fisk.

The alder flycatcher on nest.

Photograph by George Fisk



Photograph by George Fisk.

Nest and eggs of wood peewee.

The Kingbird.—This undaunted bird has the reputation of being a fighter, but it is simply a citizen who looks carefully after his rights. When it chooses a site for a nest it makes up its mind where, out in space, its line fence extends; what though this fence is like the Tropic of Cancer, in that it is quite an imaginary circle, yet woe betide the large bird, especially if it be hawk or crow, which dares to push across it. The kingbird is an example of the power of fearlessness in defending a just cause. Any one who has seen it chase a scared and squawking crow or a hawk trying to beat a dignified retreat must have paid it the mental tribute which is always due to bravery and daring.

Fully ninety per cent of the kingbird's food is insects and these are of the sort which we can best spare, such as weevils, grasshoppers, beetles which are the adults of wire-worms, etc. It has also a bad reputation among bee men, which it has done little to deserve. The United States Biological Survey has proved this by opening two hundred and eighty-one stomachs of kingbirds, and of all these only fourteen contained bees. There were only fifty bees in all, and of these forty were certainly drones and only four were surely workers. The kingbird is sufficiently astute to leave alone food with so much hot seasoning in it as worker bees are supposed to have; and by killing off drones it is a help instead of a detriment to the apiarist. The kingbird winters in Central and South America, and, therefore, appears here somewhat late in the season. It builds its nest in orchards and other civilized places, and never takes care to protect it from sight. It has implicit confidence in its own ability to protect its nest.

76. Why should the kingbird be preserved by the farmer and fruit grower?

77. Why is a pair of kingbirds of especial value near poultry yards?

78. Describe the kingbird according to the outline given for bird study in the field.

79. Have you ever seen a kingbird's nest? If so, describe it. Do you know the kingbird's note? If so, describe it.

80. Do both male and female kingbirds attack hawks and crows?

81. Have you ever seen the bright orange feathers on the crown of the kingbird's head? They are only visible when the crest is raised.

The Great-crested Flycatcher.—This is as large as the kingbird and has more of the color of the phœbe, but will never be mistaken for either on account of its habits. It lives in the woods or in old thickly grown orchards and away from people. It is especially fond of water courses through woodlands. Its favorite perch is the dead top of a forest tree. Its song is a loud interrogative exclamation, quite harsh and challenging. Mr. Chapman says that he exclaims "what" and then chuckles, but some have spelled the note "wheep." It is sufficiently startling after one has heard it never to be forgotten.

The great-crest has the strange habit of putting a cast snake skin about its nest. The reason for this probably lies thousands of years back in the history of the species and has nothing to do with present day conditions. A species of flycatcher in South America and another in Arizona have a similar habit; and they all probably inherited this habit from some ancestral bird, which perhaps devised this method for protecting its nest from some creature dreadfully afraid of snakes, like the monkey. The great-crest builds its nest in a hollow limb; its eggs are cream white, streaked lengthwise with chocolate; it winters in southern Florida and Central America.

82. Have you ever seen the great-crest? If so, describe the appearance.
83. Have you ever found a nest with a snake skin? If so, describe it.

The Phœbe.—This friendly bird which builds its nest in the piazza or under the eaves, or on the rafters of the shed or barn, or on the timber under the bridge that crosses the creek, is the most familiar to us of all the flycatchers. Its sweet, dissyllabic song is beloved by every boy and girl in the country, and is listened to with much more pleasure than that accorded to many a longer and more pretentious warble. The phœbe-note of the chickadee in spring is often confused with that of the true phœbe. The difference between these songs should be learned. A more beneficent bird than the phœbe does not exist from the human standpoint, for the phœbes spend all their time catching noxious insects; especially do they love to hover over the water and destroy mosquitoes; or if they have their nests near the barn, they spend their energies in catching the flies which annoy cattle. Ninety-three per cent of the food of the phœbe is insects, and the remainder berries of wild plants which are of no use to us. The phœbe winters in the tropics and does not arrive here until after the robins and the bluebirds.

84. Describe the phœbe by the outline for bird study in the field.
85. Have you ever seen the nest of the phœbe? If so, describe it and tell where it was situated. Of what materials is it made? The color of the eggs?
86. Do you know the note of the phœbe from the phœbe song of the chickadee when you hear either?
87. Why should the phœbe go south winters and the chickadee stay here?
88. Why should the phœbes be induced to build in cow barns and of what use are they to farmers?

The Least Flycatcher or the Chebec.—This mite of energy has a love for civilization almost as marked as that of the kingbird or phœbe. It particularly likes orchards, where it takes its place on some top-most branch and there utters its short note "chebec" over and over with many vivacious flirts of the tail. It looks like a small specimen of a wood peewee, as it usually has quite well marked wing-bars. Its note often changes from the "chebec" to "check." It is a most industrious singer and it is as noisy as it is beneficial in the orchards, where it destroys hundreds of insects every day. This little bird winters in the tropics. It builds its nest in the forks of branches and makes it daintily of finely shredded bark and hair and the down of plants and rootlets.

89. Have you ever seen the chebec? If so, when and where?
90. How would you tell the chebec from the wood peewee?
91. How distinguish it from the phœbe bird?
92. Describe the chebec according to outline given for field study of birds.

The Wood Peewee.—While this bird loves the depths of the woods, yet it is learning the advantages of civilization and the telephone wire as a point of vantage. Every year of late we have seen the peewees on the Cornell campus resting on the telephone wires "between bites." The wood peewee is a constant singer, and its plaintive, sweet trissyllabic "pee-ah-wee" is a certain means of identification. It does not flirt its tail quite so constantly nor raise its crest quite so excitedly as does the phœbe. Its ivory white wing-bars distinguish it readily from the phœbe. It is a most useful bird to our forests, feeding upon insects which injure both timber and leaves.

The wood peewee's nest is an exquisite structure; it is beautifully curved inside and made soft with fibrous materials. On the outside it is usually decorated with lichens, and is so smoothly connected with the limb on which it rests, that it seems almost a part of it.

93. Do you know the wood peewee? Where do you find it?
94. Have you heard its song? Describe.
95. Did you ever see its nest? What advantage would it be to a nest to be covered with lichens?
96. Describe the wood peewee according to outline given for field study.

A certificate will be granted to those who satisfactorily complete ten lessons or the year's work.

Address all communications to the Editor.

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